CAMEROON HIGHER NATIONAL DIPLOMA TRAINING PROGRAM

Volume 3

SECONDARY SECTOR (continuation)

September 2018
H.E. PAUL BIYA
President of the Republic of Cameroon,

“We need to radically transform the image of higher education in Cameroon”
(10th February 2008)
H.E. PHILEMON YANG
Prime Minister, Head of Government,

“In Higher Education, the Government is striving not only to increase and diversify training offers for the Cameroonian youth, but also to ensure quality, social relevance and professionalization of teachings. Furthermore, it is providing better working and living conditions to the members of the university community”

(26th November 2013)
Prof. JACQUES FAME NDONGO

Minister of Higher Education, Chancellor of Academic Orders

“We must translate into reality the new vision of the University prescribed by the Head of State through far-reaching changes that seek, amongst other things, the improvement of the quality of university services in the areas of teaching and research, to make our universities more attractive and competitive at the national, sub-regional and international levels”

(Excerpt of the New Year Wishes Speech at the University of Yaounde I, January 2010)
FOREWORD

Since November 2015, the Ministry of Higher Education has undertaken a vast and ambitious operation to review training programmes in the Brevet de Technicien Supérieur (BTS) and Higher National Diploma (HND) cycles. This initiative was incumbent on us as a categorical imperative since it became obvious that the programmes that were so far implemented had become obsolete because of the exponential evolution of the labour market.

If we recall that the programmes in question dated, most of them, as far back as 2001 and that they were developed as institutions and fields of study were set up, one easily understands why their review had become a must. Moreover, the advent of the BMD introduced innovations in our training and certification process that needed to be taken into account, especially as many BTS and HND holders now aspire to register in professional Bachelor’s and Master’s Degrees.

In order to reconcile this professional requirement with the legitimate need of students to pursue their academic programmes, we requested the support of three main stakeholders: representatives of the business world, teachers-experts from our universities and professional schools, proprietors/proprietresses of Private Institutions of Higher Education.

These three major stakeholders had the opportunity to brainstorm during the two (02) seminars we organized, the first took place on 28th November 2015 and the second on 16th March 2018, at the National Advanced School of Engineering of Yaounde I. The programmes that we are now putting at the disposal of the national university community is the fruit of their deliberations.

We can thus note that, thanks to this brainstorming, new fields of study emerged, others have been redesigned, while others have disappeared altogether, either because the labour market was already saturated, or because they had become inoperative. Trainings identified have been organized according to sectors of activity known to date: primary, secondary, tertiary and quaternary. Within these sectors, they have been divided into training areas, fields of study and specialties. We therefore have 7 major training areas, 21 fields of study and 130 specialties. These training areas have been grouped in a programme-document in 7 volumes, distributed as follows:

Volume 1: Trainings of the Primary Sector (461 pages);
Volume 2: Trainings of the Secondary Sector (356 pages);
Volume 3: Trainings of the Secondary Sector (Continued) (514 pages);
Volume 4: Trainings of the Tertiary Sector (627 pages);
Volume 5: Trainings of the Tertiary Sector (Continued) (784 pages);
Volume 6: Trainings of the Tertiary Sector (Continued) (572 pages);
Volume 7: Trainings of the Quaternary Sector (246 pages).
The seven volumes put together make a total of three thousand five hundred and sixty (3560) pages, preceded by a statutory instrument to determine the system of studies and examinations of the Brevet de Technicien Supérieur.

All this arsenal is proof, if any were needed, that our educational and certification system is resolutely embarked on the quest for its effectiveness and social relevance. It is attentive to all innovations and adapts to the developments of our society.

Through this approach, we hope to meet the expectations of our partners and provide the nation with skills that it needs to achieve her emergence by 2035.

The Minister of Higher Education

Pr. Jacques FAME NDONGO
THE MINISTER OF HIGHER EDUCATION,

- Mindful of the Constitution.
- Mindful of law No. 2001/005 of April 16th, 2001 on the orientation of Higher Education.
- Mindful of decree No. 2011/408 of December 9th, 2011 to organize the government.
- Mindful of decree No. 93/026 of January 19th, 1993 to create Universities.
- Mindful of decree No. 2001/882/PM of September 10th, 2001 setting common rules applicable to the private institutions of Higher Education.
- Mindful of Order No.99/005/ MINESUP/DDES OF November 16th, 1999 to give the general depositions applicable to the organization of studies and the evaluation of State Universities of Cameroon.
- Mindful of Order No. 01/0014/MINESUP/DDES of February 26th, 2001 organizing the study schemes and evaluations and setting the study programme fields of the HND in the Republic of Cameroon.

ORDERS:

SECTIONI: GENERAL PROVISIONS

Article 1: This Order deals with the organization of studies, assessments and syllabi of the Higher National Diploma, abbreviated "HND" in Cameroon.

Article 2:(1) The HND is a national certificate of higher education which certifies an academic and technical qualification in two years or four semesters of study after the acquisition of the Baccalaureate Certificate or General Certificate of Education, Advanced Level.

(2) It certifies that the graduate can hold a position of a senior technician and can use his / her knowledge and skills to improve upon himself / herself or pursue university studies in his/her field of study.

(3) The HND shall indicate the sector, the field and the professional specialty in accordance with the training pursued by its holder;

Article 3: (1) The HND is defined by a standard that is characteristic of the professional and cross-disciplinary skills required to obtain it.
(2) The standard referred to in paragraph (1) of this article is defined by domain and for each field by an order from the Minister of Higher Education. It lists the abilities that the diploma holders must have, specifies the knowledge and skills that must be acquired and indicates the requirements needed to obtain the certificate.

**Article 4:** Only public or private institutions of higher education duly authorized by the Minister of Higher Education can provide courses preparing candidates for the HND.

**SECTION II: THE ORGANIZATION OF STUDY**

**Article 5:** (1) Studies for the HND must last two (2) academic years or four (4) semesters after acquisition of the Baccalaureate certificate, the General Certificate of Education, Advanced Level or any diploma or certificate deemed equivalent pursuant to Article (2) above at the end of Secondary Education.

(2) However, some training programmes may require one year of preparation or upgrading, without any modification of the academic base set in Article (2) above.

(3) Where necessary, a specific text of the Minister of Higher Education shall specify the training programmes referred to in paragraph (2) of this article.

**Article 6:** (1) The academic year is subdivided into two (02) semesters. A semester consists of fourteen (14) to sixteen (16) weeks dedicated to teaching and assessment.

(2) Each semester ends with an examination session comprising a regular session and a resit session open to students who fail in the regular session under conditions set by regulatory texts.

**Article 7:** (1) Courses taught in Higher Education Institutions are organised following a structured programme.

(2) One semester has seven (7) Courses (C) with a total of 30 credits.

(3) A Course is an identifiable group of objectives and outcomes called Constituent Elements (CEs) that are scientifically coherent and specific. Each Course has a value defined in number of adjustable credits based on the pertinence of the Constituent Elements.

(4) The Constituent Elements of a CU (CECU) comprise several forms of teaching: Lectures (L), Practical work (P), Tutorials (T), Student's Personal Work (SPW); activities applied in the form of internships in companies, projects, (remove) or end-of-study projects.

**Article 8:** (1) Credit is a value or unit that is used to quantify the total workload required for the student to achieve the training objective of a CU. The number of credits allocated to each semester is thirty (30) for all the CUs of the semester. The number of hours to be taught for a credit is fifteen (15) hours spread weekly in one semester.

(2) The credits are only obtained after work has been carried out, after an appropriate assessment either during a semester, or during a year, or at the end of the course.

**Article 9:** (1) The courses are structured into compulsory Courses and Elective courses.

(2) The compulsory CUs are the set of CUs that students enrolled in an HND cycle must offer. They constitute (90%) of credits of all the CUs of the training and (100%) of credits of the
official program published by the Minister of Higher Education and required for the National Examination. They are divided into three categories:

- The compulsory CUs linked to the discipline or disciplines corresponding to the field, representing (30%) of the overall hours taught and credits allocated to the compulsory CUs.

- Professional CUs organized around technical and professional contents representing (60%) of the overall hours taught and credits allocated to the compulsory CUs.

- Cross-discipline CUs linked to complementary training in different domains, representing (10%) of the hours taught and compulsory CU credits.

(3) Elective CUs organised by each institution per its specificity, allowing the student to deepen his specialization or explore to other fields of knowledge.

**Article 10:** The Higher National Diploma cycle is done in four (04) semesters. The hours taught for a lecture credit is 15 hours, a total of 30 credits per semester consist of 450 hours of courses per semester. There is a total of 120 credits making 1800 hours of lectures for all the training in 2 years, distributed as follows per semester:

a) Fundamental courses; 2 CU, 9 credits, 135 hours.
b) Professional courses; 4 CU, 18 credits, 270 hours.
c) Cross-discipline courses; 1 CU, 3 credits, 45 hours

**Article 11:** The teaching of French and English is compulsory throughout the training in accordance with the national decision on bilingualism. Likewise, the teaching of civics and ethical education is recommended throughout the training cycle.

**Article 12:** The student is enrolled in a specialisation that he/she keeps throughout his/her training. He/She takes the cross-disciplinary lessons in general including classical aspects of the training.

**Article 13:** Practical lessons constitutes a decisive phase and is an indispensable base of the training.

**SECTION III: INTERNSHIP IN A PROFESSIONAL MILIEU**

**Article 14:** Each specialisation includes practical internships in companies. All HND candidates must complete an internship in a professional setting in one or more companies in the sector corresponding to their training.

**Article 15:** The internship in a professional setting aims at complementing the training of the candidate through the experience of professional practices corresponding to the skills required. It also allows the student to acquire qualities of rationality, professional aptitude and behaviours, and to develop a sense of responsibility by gradually adapting to the requirements of the job.

**Article 16:** (1) Internship in a professional setting is organized throughout the training leading to the HND. It constitutes an important and essential part of the student's training.

(2) No special provision may exempt an HND candidate from the obligation of carrying out an internship in a professional setting, referred to in paragraph (1) of this Article.
Article 17: (1) The search for companies or establishments to receive trainee students and the negotiation of the contents of the internship are carried out jointly by the student and the persons in charge of his/her training institution.

(2) The student's training institution is responsible in its entirety for the organisation of internship periods, their monitoring and their educational content.

(3) At the end of the internship, the candidate must produce an internship report.

(4) The institution must take all steps to find an internship for the student when the latter reports with evidence that his/her attempts to find an internship were unsuccessful.

Article 18: Internship in a professional setting is a Professional Course whose objectives and outcomes are considered in the assessments.

SECTION IV: TRAINING PROGRAM

Article 19: - The training to obtain the HND is structured into Sectors, Domains, Fields, Specialities and Options:

- A Sector consists of Domains;
- A Domain consists of Fields;
- A Field consists of Specialities from the same work-related group.
- A Speciality is a grouping of subjects forming a job profile required by the labour market.
- A Speciality may consist of options.

Article 20: The different sectors are as follows:

- Primary sector;
- Secondary sector;
- Tertiary sector;
- Quaternary sector.

Article 21: These sectors consist of the following domains:

- The primary sector includes the agro-pastoral domain, and the Water and Environmental domain.
- The secondary sector includes Industry and Technology.
- The tertiary sector includes the domains of Commerce, Management, Law, Tourism, Hospitality, Social Sciences, and Health.
- The quaternary sector includes the domains of Information and Communication Technologies

Article 22: (1) The following specialities are open in the following domains:

PRIMARY SECTOR
DOMAIN: AGRICULTURAL AND ENVIRONMENTAL SCIENCES

Field: Agricultural And Food Sciences
Specialties

1- Agricultural Engineering
2- Food Technology
3- Animal Production Technology
4- Crop Production Technology
5- Fisheries Management
6- Agro-pastoral adviser
7- Agro pastoral Entrepreneurship
8- Agricultural Business Technics
9- Aquaculture
10- Agricultural Production Technology

Field: Environmental Sciences
Specialties
1- Agro-Forestry and Forest Management
2- Nature Management and Protection
3- Risk Management
4- Pollution Prevention and Remediation
5- Meteorology
6- Solid Waste Management
7- Wildlife Management
8- Environmental Impact Assessment
9- Forest Engineering

Field: Water Engineering and Management
Specialties
1- Hydrology and Water Resources Management
2- Hydrogeology and Groundwater Management
3- Waste Water Management
4- Hydraulic Engineering and Water Infrastructure
5- Integrated Water Resource Management

SECONDARY SECTOR

DOMAIN: ENGINEERING AND TECHNOLOGY

Field: Civil Engineering
Specialties
1- Civil Engineering Technology
2- Topography
3- Urban Planning
4- Geotechnics
5- Sanitary Installation and Plumbing
6- Building Science and Technology
7- Wood Works
   Options: 7-1- Carpentry
   7-2- Joinery And Cabinetmaking
8- Real Estate Maintenance
9- Roads and Civil Engineering

Field: Mechanical Engineering
Specialties
1- Metal Construction
2- Mechanical Manufacturing
3- Mechanical Construction
4- Boiler making and Welding

Field: Chemical Engineering
Specialties
1- Chemical Manufacturing
2- Chemical Process Technology
3- Chemical Laboratory Technology

Field: Biological engineering
Specialties
1- Agricultural Biotechnology

Field: Electrical and Electronic Engineering
Specialties
1- Electronics
2- Electrotechnics
3- Electrical Power System
4- Maintenance of Industrial system
5- Maintenance of Biomedical Equipment
6- Control Instrumentation and Regulation

Field: Thermal and Energy Engineering
Specialties
1- Air conditioning and Refrigeration
2- Sustainability and Renewable energy
3- Maintenance and management of fluid system

Field: Petroleum And Mining Engineering
Specialties
1- Applied Geology
2- Drilling Technology
3- Quarries Operations
4- Petroleum Systems and Exploitation
5- Petroleum Logistics
**TERTIARY SECTOR**

**DOMAIN: MANAGEMENT, BUSINESS STUDIES AND LEGAL CAREERS**

**Field: Management**

**Specialties**

1- Assistant Manager  
2- Operation of Air Transport  
3- Management of Non-Governmental Organization (NGO’S)  
4- Project Management  
5- Human Resource Management  
6- Quality Management  
7- Logistics and Transport Management  
8- Sport Management  
9- Information Systems Management  
10- Local Government Management  
   Options:  10-1 Accounting and Finance  
           10-2 Local Government Taxation  
           10-3 Local Government Administration  
11- Statistics  
12- Events Management  
13- Port Shipping Management

**Field: Business and Finance**

**Specialties**

1- Accountancy  
2- Marketing- Trade-Sale  
3- Banking and Finance  
4- International Trade  
5- Microfinance  
6- Insurance

**Field: Legal Careers**

**Specialties**

1- Legal Assistant  
2- Business Law  
3- Land Law  
4- Stock Market Career  
5- Customs and Transit  
6- Tax Management

**DOMAIN: HOME ECONOMICS, TOURISM AND HOTEL MANAGEMENT,**

**Field: Home Economics and Social Work**

**Specialties**

1- Bakery and Food Processing  
2- Fashion, Clothing and Textiles  
3- Beauty-Esthetics  
   Options:  3-1-Beauty care and Cosmetics  
            3-2-Hairdressing Professions
4- Social Work

Field: Tourism and Hotel Management
Specialties
1- Tourism and Travel Agency Management
2- Hotel Management And Catering

DOMAIN: ARTS AND CULTURE, EDUCATION AND COMMUNICATION

Field: Education
Specialties
1- Didactics, Curriculum Development and Teaching
2- Education Management and Administration
3- Special Education
4- Distance and Continuing Education
5- Vocational Guidance and Counseling
6- Andragogy

Field: Communication
Specialties
1- Journalism
2- Advertising and Public Relations
3- Corporate Communication
4- Printing, Editing and Publishing
5- Media photography and Audio visual

Field: Arts And Culture
Specialties
1- Gastronomic Arts
2- Cinematography
3- Sculpture
4- Caricature, Illustration and Comic Arts
5- Cartoon
6- Art Design
   Options 6-1-Product Design
   6-2-Graphic Design
   6-3-Fashion Design
   6-4-Interior Design
7- Performing Arts
8- Musicology
9- Painting
DOMAIN: HEALTH
Field: Medical and Biomedical Sciences
Specialties

1- Nursing
2- Medical Laboratory Sciences
3- Medical Imaging Technology
4- Pharmacy Technology
5- Dental Therapy
6- Dental Prosthesis
7- Midwifery
8- Optician/Clinical Optometry
9- Physiotherapy
10- Nutrition and Dietetics
11- Health Care Management
12- Health Sanitary Inspector
13- Ophthalmic Technician
14- Ultrasonography
15- Prosthesis and Orthotics

QUATERNARY SECTOR

DOMAIN: INFORMATION AND COMMUNICATION TECHNOLOGY
Field: Networks and Telecommunication
Specialties

1- Telecommunication
2- Network and Security

Field: Computer Engineering
Specialties

1- Computer Engineering
 Options 1.1- Software Engineering
 1.2- Computer Science and Networks
 1.3- Data Base Management
2- Computer Maintenance
 Option 2.1- Hardware Maintenance
3- Industrial Computing and Automation
4- Computer Graphics and Web Design
5- E-commerce and Digital Marketing

(2) Other specialities and options may be created when the need arises, by Order of the Minister in charge of Higher Education.

SECTION V: ASSESSMENTS

Article 23: (1) Courses are evaluated from 0 to 100.
(2) No one may be admitted to take a Course unless he has obtained an average score of at least 50 out of 100 for all the Constituent elements of the CU.
(3) Assessment is carried out per Course. The test may consist of several sections corresponding to the constituent elements of the CU.
**Article 24:** (1) Except for the professional internship CU, each CU is assessed as follows per level:
   - Continuous assessment: 30% of the points
   - Written examination: 70% of the points

(2) The continuous assessment mark includes marks for the following:
   - Participation in tutorials and practical work;
   - Written Tests
   - Oral questions;
   - Presentations;
   - Projects.

(3) The professional internship Course includes at least two Constituent elements, one of which is dedicated to the company experience and the other to the end of training report and its defence.

**Article 25:** (1) Continuous Assessment marks are on the competence of each authorized teacher who teaches the corresponding course. At least one continuous assessment mark is required per course.

(2) The written examinations referred to in paragraph (1) of Article (24) above and all activities involved in evaluation per level are organized under the responsibility of the Management of each institution authorized to provide HND training and under the supervision of the Institution which ensures the academic supervision of the Institution concerned in accordance with the regulations in force.

(3) The transition from level 1 to level 2 is conditioned by a pass in all the CUs.

**Article 26:** (1) A National Examination taking place in a single annual session shall approve the completion of studies carried out in accordance with the provisions of this Order.

(2) The General Regulations of the National Examination for obtaining the Higher National Diploma are fixed when necessary by the Minister of Higher Education on the proposal of the National Commission for the Organization of National Examinations.

**SECTION VI: TEACHING SYLLABUS**

**Article 27:** The teaching syllabus of the training leading to the acquisition of the Higher National Diploma presented by sectors, domains, fields, specialities and possibly by options are annexed to this order.

**Article 28:** The effective opening of an HND training in an authorised public or private Institution for a field, a speciality or a given option, can occur only after a specific text of the Minister of Higher Education establishing teaching syllabuses of corresponding courses has been issued.

**SECTION VII: FINAL PROVISIONS**

**Article 29:** This order repeals all prior contrary provisions including Order No. 01/0014/MINESUP/DDES of 26 February 2001 organising the system of studies and assessments and setting the syllabus for HND courses in the Republic of Cameroon, as well as those of Order No. 05/0020/MINESUP of 12 January 2005 on the creation, system of studies, assessments and syllabi of the Higher Professional Diploma (HPD) of Higher Education Institutions of Cameroon.
Article 30: This order takes effect as of the 2018/2019 academic year.

Article 31: During the effective implementation of the new HND fields, the courses leading to HPD remain valid for a period of three (03) years.

Article 32: Heads of University Institutions, Heads of Authorized Institutions, the President of the National Commission for the Organization of National Examinations, the President of the National Commission for Private Higher Education and the Director of Development of Higher Education are responsible, in their respective spheres of competence for the implementation of this order which shall be registered and published in the official gazette in French and English.

THE MINISTER OF HIGHER EDUCATION,

[Signature]

Jacques Fame Ndongo
## SUMMARY

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DOMAIN

ENGINEERING AND TECHNOLOGY
Field: CHEMICAL ENGINEERING

Specialty:

CHEMICAL MANUFACTURING
1. The objective of the training

Design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering.

2. Research Skills

→ Generic Skills
- Work independently, collaborate in a team;
- Comprehensively analyze and synthesize of a professional document (French, English);
- Communicate orally or in writing (French, English), within or out of a company or outside;
- Participate in / lead a project management process;
- Know and exploit the professional and institutional networks of agricultural biotechnology sectors.

→ Specific Skills
- Have knowledge of the practical application of engineering science and technology;
- Have knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo;
- Have knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods;
- Have knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models;
- Have knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions;
- Have knowledge of principles and processes for providing customer and personal services.
3. Career opportunities

- Basic chemical manufacturing industries
- Soap, cleaning compound, and toilet preparation manufacturing factories
- Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
- Paint, coating, and adhesive manufacturing industries
- Pesticide, fertilizer, and other agricultural chemical manufacturing industries
- Other chemical product and preparation manufacturing
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
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<tr>
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<th>Course titles</th>
<th>Number of hours</th>
<th>Number Of Credits</th>
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<td></td>
<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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<td>CMA111</td>
<td>Laboratory Management</td>
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<td>CMA112</td>
<td>General Instrumentation</td>
<td>20 15 15 10 60</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<td>CMA113</td>
<td>General Chemistry</td>
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<td>Chemical Process Calculations</td>
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<td>CMA115</td>
<td>Introduction to Inorganic &amp; Organic Chemistry</td>
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<td>CMA116</td>
<td>Basic Physical &amp; Analytical Chemistry</td>
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<td></td>
<td><strong>Transversal Courses 10% (1 UC) 3 credits 45 hours</strong></td>
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<td>CMA117</td>
<td>Bilingual training</td>
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</table>

L: lectures; T: tutorials; P: practicals; SPW: students’ personal work

- **SECOND SEMESTER**

<table>
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<th>Course Code</th>
<th>Course titles</th>
<th>Number of hours</th>
<th>Number Of Credits</th>
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<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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<td>CMA121</td>
<td>Biochemistry for Chemist</td>
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<tr>
<td>CMA122</td>
<td>Biological and Chemical instrumentation</td>
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L: lectures; T: tutorials; P: practicals; SPW: students’ personal work
### THIRD SEMESTER

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5. Courses content

CMA 111: Laboratory Management

- **Laboratory Management**: 5 Credits (75 hours); L, T, P, SPW

**General objectives**:
- Know types of laboratories, their furnishings and fittings
- Understand the laboratory layout
- Understand the principles of designing laboratory stores
- Understand the management of stores
- Understand the principles of store keeping
- Know the acquisition, storage and use of technical informations
- Understand record keeping in the laboratory
- Understand the importance of discipline in the laboratory
- Understand routine administrative function in the laboratory

**Content**:

1. **Types of laboratories, their furnishings and fittings**
   - Explain the term ‘laboratory’.
   - Types and features of a laboratories
   - Explain the factors to be considered when designing a laboratory
   - Draw sketches of typical laboratory layout.
   - Identify laboratory furniture, giving reasons for material choice
   - List suitable materials for the laboratory
   - List essential laboratory fittings and importance

2. **The laboratory layout**
   - Describe the dimension of a standard laboratory work bench, specifying width, length, height and spacing, and types of arrangement
   - Describe the services and fittings, obtainable on laboratory bench tops.
   - Describe and explain the importance of the methods of providing lighting and ventilation in a laboratory.
   - Describe methods of evaluating illumination and efficiency of light fittings in a laboratory.
   - Explain the importance of lighting and ventilation in a laboratory.
   - Draw the layout of a typical laboratory, showing the essential services.

3. **The principles of designing laboratory stores**
   - List the factors that should be considered in the design of a laboratory store
   - Explain the importance of factors in above.
   - Draw the layout of a typical laboratory store.
   - Describe the correct sitting of a balance room in the laboratory
   - List the essential features of a balance room
- Explain and illustrate the effect of vibration, temperature and dust on balance, and how it can be minimized.
- Describe methods of transporting and installing mercury barometers.
- Describe the effect of vibration on galvanometers and how it can be minimized.
- List the types of laboratory distillers and de-ionisers and their uses.
- Describe the methods of installing distillers and de-ionisers as in above.

4. The management of stores
- List types of stores and their features.
- Explain the activities that take place in the stores listed in above.
- Explain the importance of the features stated in above.

5. The principles of store keeping
- Explain the functions of store keeper.
- Explain the legal liabilities of the storekeeper.
- Explain the use of his/store cards inventory.
- Explain government regulations relating to import.
- Outline the procedure for the purchase of various materials for the store.
- Identify the various types of documents for ordering receiving and paying for goods.
- Explain the importance of the documents listed above.

6. The acquisition, storage and use of technical informations
- List sources of information and their importance for the laboratory.
- Describe different methods of storing technical information.
- Explain the methods of retrieving, technical information.
- Describe how to store and retrieve technical information for the laboratory.
- Explain the use of technical information sources.

7. Record keeping in the laboratory
- List types of laboratory records and explain the importance.
- Explain the importance of each type of record.

8. The importance of discipline in the laboratory
- Explain the significance of hierarchy in staff structure.
- Explain the need for discipline in the laboratory environment.
- Explain qualities of leadership and good example as a basis for disciplinary practices.
- Evaluate methods of appreciation and criticism as they relate to
- Describe the methods of achieving good communication between staff and students.
- Explain the importance of a good student/staff relationship.

9. Understand routine administrative function in the laboratory
- List the minimum staff strength in the laboratory.
- Explain the importance of good/poor staffing.
- Determine the optimal staff/student ratio in a typical laboratory.
- List basic staff of a laboratory.
- List factors to be considered for asking at interviews for laboratory staff.
- Explain how the factor listed in 10.5 above can be used in interviews for laboratory staff

❖ CMA 112: General Instrumentation

➢ General Instrumentation: 4 credits (60 hours); L, T, P, SPW

General objectives:
- Understand the operation, use and care of basic measuring instruments
- Know the types of signal generators in the laboratory
- Know the types of pressure measuring instruments
- Know the types of recorders and reproducers
- Know the types of power supply units in the laboratory
- Understand the essentials of trouble-shooting techniques

Content:
1. The operation, use and care of basic measuring instruments
   - Identify basic measuring instruments
   - Classify, with examples, measuring instruments.
   - Describe the principle of operation with precautions to be taken when using the instruments in above.
   - Describe with the aid of diagrams the construction of instruments in above
   - Explain the terms: Multimeter; Multirange; Autoranging
   - Carry out set-zero and calibration adjustments in the instruments in above.
   - Measure: Voltage; Current; Resistance using the appropriate instrument in above. Weights, temperatures
   - Measure frequency, amplitude, phase relationship of signals by using oscilloscope
   - Construct measuring instruments
   - Carry out measurements using the instruments in above.
   - Carry out routine care of the instruments in above.

2. The types of signal generators in the laboratory
   - Classify signal generators
   - State the different types of waveforms produced by signal generators in above
   - Describe with the aid of suitable diagrams the operation of the signal generator listed in above.
   - Describe a typical application of each type of signal generator listed in above.
   - State the use of a signal generator in fault-finding, etc.

3. The types of pressure-measuring instruments
   - Identify the different types of instruments used in measuring pressure
   - Classify the instruments in above in relation to their operating principles.
- Describe the principle of operation of some pressure measuring instruments in above.
- Measure pressure using any of the instruments in above.

4. **The types of recorders and reproducers**
   - Identify the different types of recorders and reproducers
   - Describe the principle of operation of the recorders and reproducers commonly used in the laboratory.
   - Describe typical applications of the recorders and reproducers in above.
   - Describe routine care of the recorders and reproducers in above

5. **The types of power supply units in the laboratory**
   - Identify types of power supply unit
   - Classify direct current supply
   - Explain with the aid of diagrams how a.c. is converted to d.c.
   - Describe the construction of typical power supply units.
   - Outline the precautions to be observed when using power supply units.
   - Describe the application of power supply units and their limitations

6. **The essentials of trouble-shooting techniques**
   - Identify tools for trouble-shooting
   - Obtain necessary information from the operator and from service manuals about a given instrument.
   - Check: (a) Continuity (b) Availability of power etc. in the instruments in above.
   - Trouble-shoot instruments such as overhead projector, PH meter etc.
   - Detect defective modules or pants in instruments using the tools in above.
   - Repair or replace the defective module pants in above.

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**CMA 113 : General Chemistry**

- **General Chemistry: 5 credits (75 hours); L, T, P, SPW**
  1. Atomic Structure and bonding
  2. Electron Configuration Of Elements
  3. Ionic And Covalent Bonding
  4. Intermolecular Forces of attractions
  5. Chemical Equilibria and phase diagrams
  6. Concentrations of Acids And Bases, Acid Base Concepts
  7. Solubility and Complexions

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**CMA 114 : Chemical Process Calculations**

- **Chemical Process Calculations: 5 credits (75 hours); L, T, P, SPW**
  1. Units, dimensions and conversions,
  2. Temperature and Pressure scales,
3. Composition of mixtures,
6. Sub-systems and interconnections.
10. Balances for systems with recycle, purge and by-pass streams
11. Mass balances for reactive processes and unit operations.
12. Tie components.

CMA 115: Introduction to Inorganic & Organic Chemistry

- Introduction to Inorganic & Organic Chemistry: 4 Credits (60 hours): L, T, P, SPW
  1. Overview of periodic table: molecular orbital theory:
  2. Chemistry of solutions:
  3. Chemistry of transition metals, coordination compound and radioactive elements.
  4. Crystalline state of metals and lattice structure.
  5. Industrial inorganic Chemistry.
  6. Qualitative and group theory of inorganic Chemistry.
  7. Functional groups, Inter conversion of functional groups.
  8. Unit Processes reaction mechanism of sulfonation; nitration; hydrogenation;
  9. amination; halogenation, oxidation, polymerization

CMA 116: Basic Physical & Analytical Chemistry

- Basic Physical & Analytical Chemistry: 4 credits (60 hours): L, T, P, SPW
  2. Electrochemistry, including fuel cells
  3. Colloidal chemistry, reaction kinetics and equilibrium.
  4. Introduction to instrumental techniques involving potentiometry, pH
  6. Spectroscopy: Basics of spectroscopy, UV and visible spectroscopy
CMA 117: Bilingual training

- **English**: 1.5 credits (22 hours 30mn)); L, T, SPW

  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty

  2. **Grammar**

  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication

  4. **Autonomous reading of “writings” of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
     - C.V;
     - Letter of motivation;
     - Letter/memo writing and minutes of a meeting

- **French**: 1.5 credits (22 hours 30mn)); L, T, SPW

  1. **Vocabulaire**
     - Vocabulaire du matériel de technologie agro-alimentaire
     - Vocabulaire des produits agro-alimentaires
     - Vocabulaire des activités agro-alimentaires
     - Vocabulaire des actants
     - Vocabulaire des affaires

  2. **Grammaire**
     - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
     - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
     - Du nom et son article : masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
     - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
     - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
     - Des fonctions grammaticales.

  3. **Expression et communication**
     - Compréhension et interaction au cours d’une discussion technique ;
- Communication orale courante ;
- Communication orale interactive ;
- De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
- Lecture rapide et compréhension de texte ;
- Synthèse de texte
- De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV :
- Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
- Expressions figées

❖ CMA 121: Biochemistry for Chemists

➢ Biochemistry for Chemists: 4 Credits (60 hours); L, T, P, SPW

General objectives:
- Understand carbohydrate, protein and lipid
- Understand the phenomenon of intermediary metabolism
- Understand the pathways of carbohydrate, protein and lipid metabolism
- Understand enzymes

Contents:
1. Carbohydrate, protein and lipid
   - Know the structures of the common amino acids
   - Understand that amino acids are linked by peptide bonds to give polypeptide chains
   - Know that proteins consist of one or more polypeptide chains
   - Know the common conventions and be able to use shortened nomenclature to give the sequence of a polypeptide chain
   - Know the common techniques used to purify proteins
   - Know an experimental technique for sequence determination based upon degradation
   - Understand that the 3D shape of a protein may be obtained from single crystal X-ray diffraction experiments
   - Know the local folding (conformations) motifs for polypeptide chains
   - Understand primary, secondary, tertiary and quaternary structure.
   - Understand that the shape and function of the protein is defined by its primary sequence
   - Be familiar with models of some simple proteins (e.g. albumin, ribonuclease, etc) and relate structure with function.
   - Carbohydrate: Definition, Mono-, di-, tri-, oligo-, poly-saccharides,
   - Nomenclature and types of bonds
   - Physicochemical Properties
   - Lipids: Definition
2. **The phenomenon of intermediary metabolism**

- Explain that metabolism in a living cell constitutes catabolic (breakdown) and anabolic (synthesis) processes which occur simultaneously.
- Explain intermediary metabolism as the interchange ability of derivatives (metabolites) of carbohydrates, proteins and fats (lipids) via reactions mediated by appropriate enzymes and coupled by relevant coenzymes/cofactors.
- Illustrate the central role of acetyl CoA in intermediary metabolism and describe how the energy for cellular metabolism is derived from the breakdown of acetyl COA.
- Explain how the energy from above is captured in the form of ATP (adenosine triphosphate) which is reversible.
- Describe ATP cycle and outline ATP as the universal energy currency in biological systems.
- Explain how energy released from the degradation of some substrates may be utilized in the formation of other cellular components.
- Explain that the sum total of breakdown of carbohydrates, fats and proteins is a chain reaction involving transfer of reactions which lead to the final products of cellular respiration (CO2 + H2O) and ATP.

3. **The Pathways of carbohydrate, protein and lipid metabolism**

- List the enzymes and products of digestion of carbohydrate and explain the term ‘substrate level phosphorylation’.
- Define glycolysis as the pathway of breakdown of phosphorylated sugars to provide energy and lactate.
- Describe the glycolytic pathway and the conversion of pyruvate to acetyl COA.
- List the key enzymes of glycolysis.
- Identify the steps that consume or yield energy in the glycolytic pathway.
- Deduce the net energy yield of this glycolytic pathway.
- Distinguish between aerobic and anaerobic glycolysis.
- Define oxidation of fatty acids.
- Describe the processes occurring in fatty acid oxidation (activation dehydrogenation, hydration, further dehydrogenation and Thiaclastic cleavage).
- Describe the b oxidation of fatty acids to acetyl COA.
- Explain that the acetyl COA produced in fatty acid oxidation enters the TCA cycle for further degradation.
- Describe the oxidation Via propionic acid of branched and odd-numbered fatty acids.
• Explain that FADH2 and NADH + H+ produced in fatty acid oxidation are also oxidized through the electron transport system of the mitochondria eventually by molecular oxygen.
• Compare the energy yield when one mole each of saturated and unsaturated fatty acids of equal chain length are completely oxidized.
• Describe the formation and metabolism of ketone bodies (acetone, acetoacetate and \(\text{p}\)-hydroxy butyrate).
• Describe the biosynthesis of fatty acids.
• Describe the two pathways of fatty acid biosynthesis (cytoplasmic, mitochondrial).
• Explain that the cytoplasmic pathway is the major pathway of fatty acid synthesis.
• Describe the biosynthesis of triglycerides and phosphatides.
• Describe the biosynthesis of sterols from cholesterol.
• List the enzymes and products of protein digestion.
• Explain how amino acids can be a source of cellular energy.
• Explain how the carbon skeleton of amino acids are either converted into fatty acids and glucose or oxidized via the TCA cycle.
• Explain the terms: ketogenic and glucogenic amino acids.
• List ketogenic and glucogenic amino acids.
• Explain transamination and oxidative deamination.
• Write chemical equations to illustrate the process in above.
• Describe the formation of urea.

4. Enzymes
• Describe the distinctive features of enzymes.
• Explain enzymes specificity as the basis of classification.
• Explain and determine enzymatic catalysis measurement by the rate of disappearance of substrate or formation of products.
• Determine the effect of activators and inhibitors experimentally.
• Define enzyme activity and specific enzyme activity in international units (IU) and SI unit. Explain methods of enzyme assay.
• Explain how an enzyme reversibly combines first with its substrate to form an enzyme substrate complex.
• Explain why the process of product formation from above is a slow process.
• Explain the term Rapid Equilibrium.
• Explain steady state and Pre-steady state.
• Explain and determine enzymecatalysed reactions measurement under initial rate (Vo) conditions.
• Derive the Michealis-Menten equation from the expression:
• Explain the Kinetic constant, \(K_m\), \(V_{max}\), \(K_{cat}\).
• Explain the physiological significance of \(K_m\).
• Describe the determination of \(K_m\) and \(V_{max}\) by using line weaver Buck plots.
- Show that Km and Vmax can also be determined by Eddie-Hoffsted plots.
- Define cofactors, activators, coenzymes and prosthetic groups.
- Explain how the rate of enzymatic catalysis can be affected by the presence of cofactors and inhibitors.
- Define reversible inhibitors.
- Distinguish between competitive, uncompetitive and non-competitive inhibitors.
- Describe transition state analogues as reversible inhibitors and relate this to chemical structure.

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**CMA 122: Biological and Chemical Instrumentation**

- **Biological and Chemical Instrumentation:** 5 credits (75 hours); L, T, P, SPW

**General objectives:**
- Understand the principles and instrumentation of spectrophotometer and colorimetry.
- Know the operation and care of flame photometer and Raman spectrometers.
- Know the operation and care of Atomic absorption spectrophotometers (AAS).
- Know the operation and care of the X-ray spectroscope.
- Know the operation and care of electrolytic conductivity bridge; coulometer titration; PH meter; autotitrator; polarograph.
- Know the operation and care of radioactive detectors and counters.
- Understand the operation and care of gas chromatographic equipment, fluorimeter, polarimeter and refractometer.
- Know the concept of hydrogen ion concentration.
- Know the various types of electrodes used in measuring ions like fluoride, nitrate, etc.
- Know use of microscopes.
- Know the principles of autoradiography.
- Know the use and maintenance of photomicrographic equipment.
- Know the use and maintenance of colony counter.
- Know the use and maintenance of autoclave, centrifuge and incubator.
- Understand the principle of automation and its significance in chemical analysis.

**Contents:**

1. **The principles and instrumentation of spectrophotometer and colorimetry.**
   - State the wave length within the electromagnetic spectrum.
   - Distinguish between wavelength of light within the visible region and invisible region.
   - Explain the similarities in the working principle of the colorimeter and spectrophotometer.
   - Identify the various parts of a colorimeter.
   - Explain the functions of the parts in 1.4 above.
• State basic similarities and differences between a colorimeter and spectrophotometer.
• Explain the limitations of colorimeter in microbiological studies.
• Explain the term spectrophotometry.
• List the various sources of light for spectrophotometric determination.
• Describe diffraction grating
• Explain the functions of diffraction grating in spectrophotometry.
• Explain the term interference filter.
• State the function of optical filter in spectrophotometry.
• State the basic laws of spectrophotometry viz: Bonger Lambert’s law, Beer’s law.
• Explain the working principles of the spectrophotometer.
• List the functions of the parts in the optical system of a spectrophotometer.
• List the different types of detections used in spectrophotometry.
• List the functions of parts in the optical system of a spectrophotometer.
• List the different types of detection used in spectrophotometry.

2. The operation and care of flame photometers and Raman spectrophotometers
• Explain the principle of operation of the flame photometer.
• Identify the various parts of a photometer.
• State the functions of the various parts of atomizer, e.g. carbon rod.
• State the similarities and differences between the spectrophotometer and flame photometer.
• List the errors inherent in practical flame photometry and how they can be corrected particularly as applied to biology.
• Explain how to correct the errors in above.
• Describe and carry out typical maintenance routines for the flame photometer
• Identify parts of the Raman Spectrometers.
• Explain the functions of the parts in above.

3. The operation and care of Atomic Absorption Spectrophotometers (AAS)
• Draw a schematic labeled diagram of the AAS.
• Identify the parts of an AAS e.g. extension sources.
• Describe the working principle of each of the component parts of the AAS (especially the hollow cathode lamp).
• Outline the steps for operating the AAS

4. The operation and care of the X-ray spectroscope
• Identify the parts of the X-ray spectroscope.
• Describe the parts listed in 4.1 above.
• Draw a block diagram of an X-ray spectroscope.
• Describe the operation and working principles of the units such as collimation, filters, analyzing crystals and detectors.
• Draw non-dispersive X-ray absorption meter.
• List the parts of an X-ray fluorescence spectrometer.
• Identify and describe parts of an X-ray fluorescence spectrometer.

5. **The operation and care of analytical instruments**
• List the component parts of:
  – Electrolytic conductivity bridge
  – Coulometric titration
  – Autotitration
  – pH meter
  – Polarograph.
• Identify and describe the various parts of the instruments in above.
• Explain the principle of operation of the instruments in above.

6. **The operation and care of radioactive detectors and counters**
• List the various radioactive detectors and counters with photographic envision, ionization chambers and proportional counters, scintillation counters, semi-conductor detectors, Geiger-Muller counter.
• Explain the operation of each detector and counter in 6.1 above.

7. **The operation and care of gas chromatographic equipment fluorimeter, polarimeter and refractometer**
• Explain gas chromatography
• Identify the parts of:
  – Gas chromatograph
  – Fluorimeter
  – Polarimeter
  – Refractometer
• Explain the working principles of each instrument in above

8. **Concept of hydrogen in concentration**
• Explain the term pH
• Explain why the pH scale ranges from 0 to 14.
• State Bronsted-Lowry theory of acid and base.
• Calculate the pH of an acid and a base applying the theory in above.
• Explain the functions of buffer with example.
• Enumerate the main problems involved in pH measurement.
• Explain how the problems in above are overcome.
• Describe the potentiometric method of determination of pH.

9. **Types of electrodes used in measuring ions like fluoride, nitrate, etc.**
• Identify ion – selective electrodes
• State the uses of ion - selective electrodes
• Explain the basic principles of operations of an ion-selective electrode.
• Explain the relationship between activity and concentration of an ion.
• List the various types of gas measuring electrodes.
• Identify an oxygen electrode.
• Identify the various uses of an oxygen electrode.
• List and describe electrodes for pH measurement
• Describe the routine maintenance of electrodes
10. **The use of microscopes**
   - Define microscopy
   - List various techniques of microscopy e.g. bright field, dark field etc.
   - Explain the techniques in above.
   - Identify various types of microscopes.
   - Identify the parts of the microscopes in above.
   - Explain the principles of operation of the microscopes in above (elementary treatment only).

11. **The principle of autoradiography**
   - Explain autoradiography
   - Identify the components used in autoradiography
   - Describe the applications of autoradiography
   - Demonstrate the techniques of autoradiography.

12. **The use and maintenance of photomicrographic equipment**
   - List the applications of photomicrography equipment.
   - Explain the working principles of photomicrography equipment.
   - Describe the working parts of photomicrography equipment.

13. **The use and maintenance of colony counters**
   - Identify types of bacterial colony counters.
   - Identify the parts of the counter in 13.1 above.
   - Explain the function of each part in 13.2 above.
   - Describe the principle of operation of the colony counter

14. **The use and maintenance of autoclave, centrifuge and incubator**
   - State the functions of:
     - Autoclave
     - Centrifuge
     - Incubator.
   - Identify the parts of the instruments above.
   - Explain the functions of the parts above.

15. **The principle of automation and its significance in chemical analysis**
   - Know the importance of automation.
   - Explain the following terms as they relate to automation: (i) Precision (ii) Reliability (iii) Speed (iv) Accuracy
   - Know the tasks involved in automation e.g. dispensing of samples and reagent in precise, predetermined volume
     - Mixing of samples with reagent
     - Incubation
     - Recording of absorbance
     - Calculation and determine results
     - Printing the results.
   - Differentiate between semi automated and fully automated analysers e.g. batch analyzer, semi automated, random access.
   - Know the terminologies used in automation.
CMA 123 : Chemical Process technology: 5 credits (75 hours); L, T, P, SPW

- Chemical Process technology: 5 credits (75 hours); L, T, P, SPW
  1. History & Development of Chemical Process Industry;
  2. Fertilizer and pesticides,
  3. Petroleum refining, gas processing, pulp and paper, sugar
  4. Heavy chemicals (acids, alkali and salts), cement and ceramics, glass,
  5. Polymer and rubber, food and beverages, soaps and detergents,
  6. Water treatment and purification, paints, powder coating, varnishes,
  7. Synthetic fiber and artificial leather .
  8. Applications of sustainable and green technology.

CMA 124 : Engineering Thermodynamics

- Engineering Thermodynamics: 5 credits (75 hours); L, T, P, SPW
  1. Introduction, thermodynamic systems and processes,
  2. Equilibrium thermodynamic variables,
  3. Intensive and extensive variables,
  4. Thermodynamic properties,
  5. State functions, derived intensive variables.
  6. Types of work, kinetic and potential energy,
  7. First law of thermodynamics,
  8. Internal energy, energy transfer by heat,
  9. Energy balance and energy analysis of cycles
  11. Property relations relevant to engineering thermodynamics
  12. Fundamental thermodynamic functions

CMA 125 : Chemical Reaction Engineering

- Chemical Reaction Engineering: 4 credits (60 hours); L, T, P, SPW
  1. Kinetics of homogeneous reactions: Rate of reaction, variables affecting the rate of reaction, order of reaction, rate constant;
  2. Searching for a mechanism of reaction,
  3. Activation energy and temperature dependency,
  4. Interpretation of batch reactor data for single and multiple reactions.
  5. Design of homogeneous reactors:
  7. Temperature and pressure effects. Adiabatic and non-adiabatic operations.
  8. Design of heterogeneous reactors:
  9. Surface phenomenon and catalysis, adsorption/desorption isotherms,
10. Heterogeneous reaction systems, rate equations for heterogeneous reactions,
12. Catalyst deactivation and regeneration.
13. Design of fixed bed and fluidized bed catalytic reactors.

**CMA 126 : Workshop Practices**

- Workshop Practices: 4 credits (60 hours); L, T, P, SPW
  1. Providing hands on training of workshop practices
  2. Laboratory and Practical exercises relating to the topics covered in theory.

**CAM 127: Computer Science and Entrepreneurship**

- Computer Science : 2 credits (30 hours); L, T, P, SPW
  Computer structure, introduction to some basic computer software’s (World, Office, Excel, SPSS, Epi Info, Matlab), using computer software for data analysis, information and data transfer, storage and security, using internet and social networks.

- Entrepreneurship: 1 credits (15 hours); L, T, SPW
  1. Concept of an entrepreneur
  2. Motivations in the creation of a business
  3. Search for ideas and evaluation
  4. Search for funding
  5. Choice of legal status
  6. Ethical aspects of business

**CMA 231: Computer Applications in Chemistry**

- Computer Applications in Chemistry: 4 credits (60 hours); L, T, P, SPW
  General objectives:
  - Be able to use chemistry drawing packages such as "Chem Draw" or "ISIS Draw".
  - Be able to use molecular modelling packages such as "Chem3D" or similar
  - Be able to use specialist graph plotting and analysis software packages such as "Origin", "Sigmaplot", "Igor" or similar.

  Content:
  1. Use chemistry drawing packages such as Chem Draw or ISIS Draw
  Students should be able to:
     - Launch the drawing package, create new documents, save documents and open existing documents.
Use menus to set or select drawing preferences such as bond length, bond angles, line width, page set up, etc.
Select drawing tools from the menus to draw new bonds, add new bonds, and construct drawings of very simple organic molecules
Print the drawing.
Draw double and triple bonds
Draw rings by using the appropriate ring tool or template from the menus
Draw fused rings by using the same ring tools as above
Add atom labels to drawings/repeat atom labels and delete atom labels
Add captions to drawings
Format text
Use orbital tools to select and draw orbitals
Use chemical symbol tools to select and draw lone pairs, radicals, and charges.
Select and use the appropriate tools to draw: reaction arrows, arcs, and other shapes.
Use the eraser tool to delete individual bonds, charges, arrows, etc.
Select objects by using the selection tool
Select objects by using the mouse buttons
Add to the selection and delete the selection
Select and move objects
Select and duplicate objects
Select and rotate objects
Select and resize objects
Select and group objects
Select and align objects
Use the crosshair
Cut and paste within the package
Cut and paste from the package into other packages such as word processing packages

2. Use molecular modelling packages such as "Chem3D" or similar
- Explain the reasons for modelling molecules and reaction intermediates on computers
- Understand the general concepts involved in computer molecular modelling
- Understand the mathematical principles underlying modeling procedures (Newtonian Mechanics [e.g. MM2], semi empirical [e.g. MOPAC] and quantum mechanical methods.
- Discuss the relative merits of the different methods of modelling given above.
- Launch a modeling programme and create an empty model page or window
- Select a pre-existing model from a template menu
- Use rotation tools to rotate and examine the molecule
- Save the new rotation and print the new view
- Open an existing file
- Import a model created by the same or a different modelling programme
- Build a new molecule by using the tools available in menus
- Build a new model by using a drawing programme and importing the resulting file into the modeling programme
- Change an atom to another element
- Change bonds
- Add fragments
- Delete atoms and bonds
- Set charges
- Change stereochemistry
- Select atoms, bonds or groups of atoms and bonds by using the selection tools from menus
- Select atoms, bonds and features by using the mouse buttons
- Move atoms or models
- Rotate fragments of models
- Change orientations of fragments
- Resize models
- Change the appearance of a model (wire frame, sticks, ball and stick, spacefilling, dot surfaces, ribbons, etc)
- Change colours
- Change atom and bond sizes
- Change element symbols
- Display stereo views
- Display model data (atoms and serial numbers, bond angles, dihedral angles, distance between two atoms, etc)
- Dock models
- Compare models by overlaying
- Export using different file formats
- Export by using the clipboard
- Use the modeling programme to compute the stability of different conformations of the same simple molecule
- Use the modeling programme to minimise the energy of molecules
- Use the modeling programme to find the lowest energy conformation of simple and more complex molecules e.g. aspirin
- Use the semi-empirical functions [MOPAC] of the programme to determine ΔHf.

3. **Use specialist graph plotting and analysis software packages such as "Origin" or "Sigmaplot" or "Igor" or similar**
   - Explain the relationship between a specialist graph plotting and analysis programme and a spreadsheet programme such as Excel.
- Launch the specialist graph plotting and analysis programme
- Input data directly into the programme’s worksheet
- Import data into the worksheet from a spreadsheet package such as Excel
- Use menu commands to plot a graph of the data contained in the worksheet
- Use menu and or mouse commands to edit resulting graph (change: axes, labels, symbols, text, resizing, etc)
- Save graphs and data files
- Save files in different formats (e.g. “standard formats such as TIF files)
- Export data files and graphs into other programmes such as spreadsheets and word processors
- Use menu commands to analyse data in the worksheet
- Obtain basic statistical from the data in the worksheet (statistics on rows and columns, t-tests, ANOVA, etc)
- Use the curve fitting functions e.g. exponential, linear regression, sigmoidal, hyperbolic, etc.
- Use the hyperbolic functions to analyse Michaelis Menten kinetics and obtain the kinetic parameters for suitable enzyme catalysed reactions

**CMA 232: Petroleum and Petrochemicals**

- **Petroleum and Petrochemicals: 5 credits (75 hours); L, T, P, SPW**

**General Objectives:**
- Know the primary raw materials for petrochemicals, treatment processes and properties
- Know the hydrocarbon intermediates (secondary raw materials) for the production of petrochemicals
- Understand crude oil processing and the production of hydrocarbons
- Know the extraction and uses of non-hydrocarbon intermediates
- Describe petrochemicals based on methane
- Describe petrochemicals based on ethane and higher paraffins
- Describe petrochemicals based on ethylene
- Describe petrochemicals based on propylene
- Describe petrochemicals based on C4 Olefins and Diolefins
- Describe petrochemicals based on benzene, toluene and xylene
- Be familiar with synthetic petroleum based polymers

**Content:**

1. **The primary raw materials for petrochemicals, treatment processes and properties**

Students should be able to
- Discuss the origin of petroleum raw materials
- Know the composition of Natural Gas
- Describe treatment processes for Natural Gas
• Discuss Natural Gas Liquids (NGL)
• Describe properties of Natural Gas
• Know the composition of crude oils
• Describe the properties of crude oils
• Understand crude oil classification

2. **The hydrocarbon intermediates for the production of petrochemicals**
   • Know the paraffinic hydrocarbons (methane, ethane, propane, and butanes) and their role as secondary raw materials
   • Know the olefinic hydrocarbons (ethylene, propylene, butylenes) and their role as secondary raw materials
   • Discuss the dienes: butadiene and isoprene
   • Describe the extraction of aromatics and discuss their role as secondary raw materials
   • Discuss Liquid Petroleum Fractions and Residues: Naphtha, Kerosine, Gas Oil, Residual Fuel oil

3. **Crude oil processing and the production of hydrocarbons**
   • Physical separation processes: atmospheric and vacuum distillation, absorption, adsorption, and solvent extraction
   • Conversion processes: thermal processes and catalytic conversion processes alklylation processes, isomerisation processes etc
   • Production of olefins: steam cracking
   • Production of diolefins

4. **Extraction and uses of non-hydrocarbon intermediates**
   • Know the extraction and uses of hydrogen
   • Know the extraction and uses of sulphur
   • Know the extraction and uses of carbon black
   • Discuss the production and uses of synthesis gas

5. **Describe petrochemicals based on methane**
   • Discuss the direct conversion of methane into: carbon disulphide, hydrogen cyanide, chloromethanes.
   • Describe the production of methanol from synthesis gas
   • Discuss the uses of methanol as a fuel
   • Describe the uses of methanol as a feedstock
   • Discuss the production of hydrocarbons from methanol
   • Know the MTG process (methanol to Gasoline)
   • Know the production of ethylene glycol (anti-freeze) from synthesis gas.

6. **Describe petrochemicals based on ethane and higher paraffins**
   • Describe the isolation and uses of ethane
   • Describe the isolation and uses of propane
   • Discuss reactions of propane and uses of the resulting products
   • Describe the isolation and uses of butanes
   • Discuss reactions of butanes
   • Discuss petrochemicals from high molecular weight n-parafins (oxidation, chlorination, sulphonation, etc)
7. **Describe petrochemicals based on ethylene**
   - Describe the production and isolation of ethylene
   - Know the importance of ethylene in the petrochemical industry
   - Discuss the production of ethylene oxide and its uses as a feedstock in the production of derivatives
   - Know the carbonylation, chlorination, hydration, and oligomerisation of ethylene
   - Discuss alkylation using ethylene

8. **Describe petrochemicals based on propylene**
   - Describe the production and isolation of propylene
   - Discuss the oxidation of propylene
   - Know the oxyacylation of propylene
   - Discuss the hydration of propylene and the uses of isopropanol
   - Describe the hydroformylation of propene

9. **Describe petrochemicals based on C4 Olefins and Diolefins**
   - Describe the isolation of n-butene, isobutene and butadienes
   - Discuss the oxidation of n-butenes and uses of the resulting petrochemicals
   - Discuss the production and uses of petrochemicals from isobutylene: oxidation, epoxidation, addition of alcohols, hydration, carbonylation, and dimerisation
   - Discuss the production of petrochemicals from butadiene: adiponitrile, hexamethylene diamine, adipic acid, and butanediol

10. **Describe petrochemicals based on benzene, toluene and xylenes**
    - Describe the isolation of benzene, toluene and xylene
    - Describe the reactions of benzene (alkylation, chlorination, nitration, oxidation, and hydrogenation) and uses of the resulting products
    - Describe the reactions of toluene (dealkylation, disproportionation, oxidation and carbonylation)
    - Know the production of terephthalic acid, Phthalic anhydride and isophthalic acid from xylenes.

11. **Synthetic petroleum based polymers**
    - Discuss the importance of synthetic petroleum based polymers
    - Discuss thermoplastics (polyethylene, polypropylene, PVC, polystyrene, Nylon resins and thermoplastic polyesters
    - Discuss thermostetting plastics: polyurethanes, epoxy resins, unsaturated polyesters
    - Discuss synthetic rubbers: butadiene polymers and copolymers, nitrile rubbers, polisoprene and butyl rubber
    - Discuss synthetic fibres: polyester fibres, polyamides, acrylic and modacrylic fibres, carbon fibres and polypropylene fibres.
CMA 233: Chemical engineering thermodynamics

- Chemical engineering thermodynamics: 5 credits (75 hours); L, T, P, SPW

  1. General Vapour-Liquid Equilibrium (VLE) behaviour: Equilibrium
  2. VLE calculations – Bubble point, Dew point and Flash calculations.
  3. Partial molar quantities; Excess properties
  4. Chemical potential, fugacity and activity coefficients; Theory and applications.
  5. Chemical reaction equilibrium and equilibrium constants; single and multi-reaction equilibria, Dependence of equilibrium constant on T, P, and composition.
  6. Chemical and phase equilibrium, phase transitions, Gibbs free energy and phase diagrams, chemical potential, chemical potential in solutions, ideal reacting gas mixture.
  7. Calculations in Phase Equilibria: Liquid-Liquid; Liquid-Solid
  8. Thermodynamic Analysis of Chemical Processes
  9. Introduction to Statistical Thermodynamics

CMA 234: Chemical plant Design

- Chemical plant Design: 4 credits (60 hours); L, T, P, SPW

  1. Process design and development. General design considerations.
  2. Health and safety
  3. Design codes and standards.
  4. Vessel design: Low, medium and high pressure storage and transportation vessels; Cryogenic vessels.
  5. Design of mass transfer equipment; material transport; material handling
  6. Heat transfer equipment including furnaces and refrigeration units
  7. Piping and pipeline design.
  8. Basic Concepts of Optimization :Optimization of Unconstrained Functions
  9. Linear Programming Applications; Non-Linear Programming with Constraints
  10. Engineering Ethics
  11. Local, Global Impact Analysis

CMA 235: Chemistry Process Design

- Chemistry Process Design: 5 credits (75 hours); L, T, P, SPW

  1. Hierarchy of process design;
  2. Process synthesis and design strategy.
  4. Separation system selection and design.
6. Optimization
7. Introduction to various design and simulation software
8. Development of process flow diagrams for various process industries

❖ CMA 236: Instrumentation & Process Control

❖ Instrumentation & Process Control: 4 credits (60 hours); L, T, P, SPW

1. Study of scientific principles employed in instruments; sensors, modifiers, recorders etc.
2. Dynamic and static properties of instruments; selection and calibration
3. Instruments; error analysis of process measurement
4. Instrument identification and line symbols;
5. Available technology of instrumentation for temperature, flow, level, weight, load, pressure, and composition measurement.
6. Transducers; advanced measurement devices employing piezoelectric current, ultrasonic, laser, microwave etc.
7. Installation and installation costs; case studies
8. Introduction and significance of control;
9. Feedback and feed forward control;
10. Design and hardware elements of control;
11. Dynamics of first and second order systems;
12. Overall transfer function testability; controllers and final control elements;
13. Representation of control systems; multiple control loops; cascade, ratio, over-riding
14. Introduction to stability of chemical processes;
15. Introduction to frequency response techniques;
16. Computer control,
17. Introduction to distributed control systems; case study

❖ CMA 237: Civic Education and Ethics/ Initiation to the Law

❖ Civic Education and Ethics: 1.5 credits (22 hours 30 min);
   ▪ The citizen;
   ▪ The Nation;
   ▪ The State;
   ▪ Publics Property unto collective’s goods;
   ▪ The freedoms;
   ▪ The public service;
   ▪ Ethics;
   ▪ Ethics, Law and reason;
   ▪ Ethical Problem ;
Management and ethics of responsibility;
- Ethics and management.
- Codes of ethics
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- Explain the importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Protection of the environment
- Some moral figures through national and foreign history

Initiation to the Law : 1.5 credits (22 hours 30 min);
Objective: At the end of this course, students should be able to identify and explain some fundamental principles of business law, distribution law, labour law and intellectual property law. Students are equally expected to understand the rules and legal provisions regarding the internal and external operations of a corporate body including the powers of executive.

Courses Content
1. Business Law;
2. Distribution Law;
3. Labour Law;

CMA 241: Forensic Biochemistry

Forensic Biochemistry: 5 credits (75 hours); L, T, P, SPW

General Objectives:
- Understand the metabolism of foreign compounds (Xenobiotics) in the body.
- Understand the analysis of materials of forensic interest.

Content:
1. The metabolism of foreign compounds (Xenobiotics) in the body.
   - Describe drugs as foreign chemical compounds in the system.
   - Classify drugs as acidic, basic and neutral.
   - Explain the role of the liver enzymes in foreign compound metabolism.
   - Describe the characteristics of foreign compound metabolizing enzymes.
   - Explain the role of the smooth Endoplasmic reticulum in foreign compound metabolism. Explain the two phases in the metabolism of foreign compounds (phase I and II).
   - Explain the reason and the effects of drug metabolism
 Explain how the effect (metabolism) of a drug in the system depends on such factors as the structure of the compound route of administration, sex and strain and species of animal, presence of other chemicals, diet etc.

 Explain the terms: toxicity, carcinogenicity, mutagenicity teratogenicity etc.

 Explain the effects of drugs on tissues in terms above.

 Describe the various routes of excretion of drugs and their metabolites (breakdown products) e.g. exhaled air, sweat, saliva, urine, bile and other body fluids.

 Explain the importance of the study of rate of urinary excretion of drugs in forensic science.

 Explain drug-drug interactions in the body.

2. Analysis of Materials of forensic interest.

 Explain forensic science.

 Describe the collection, preservation and forwarding of materials of forensic interest to the laboratory.

 Explain the need for proper storage of materials for forensic analysis.

 Explain the importance of preserving some portions of a sample for further reference.

 Describe the duties of the toxicologist.

 Describe the various groups of poisons.

 Explain the methods of extraction and identification of compounds of forensic interest.

 Describe the extraction and identification of poison and drugs.

 Explain metallic poisoning, indicating where they are deposited in the body.

 Describe the methods of extraction and specific identification of 2.9 above.

 Describe blood groups and rhesus factors.

 Explain blood group typing and parentage dispute as well as their relationship.

 Describe the various types of body fluids.

 Describe qualitative methods of identification of blood strains, urine and saliva.

 Describe various presumptive (preliminary) tests employed on body fluids (e.g. blood; saliva, serum) before specific confirmatory tests.

 Explain species identification for blood strain.

 Carry out test on blood stains, saliva, smina stains and species identification.

 Define and classify hard drugs.

 Describe methods of purification of such hard drugs and compare results with the normal level (data) set by Nigerian standards organization, food and Drug administration (FDA) and World Health Organisation (WHO) and similar bodies.
- Describe standard confirmatory methods of analysis of hard drugs.
- Describe spot test for drugs of forensic interest.
- Make proper deductions from all available data.
- Build up result/data banks for future references.
- Explain presentation pattern of work reports.
- Explain why the analyst must report only his findings.

**CMA 242: Food Chemistry and Brewing**

- Food Chemistry and Brewing: 4 Credits (60 hours); L, T, P, SPW

**General Objectives:**
- Understand the major classification of food and food preservation techniques
- Know some basic biotechnology of food
- Understand the chemical principles and processes involved in beer brewing

**Content:**

1. **Classification of food and food preservation techniques**
   - Classify Foodstuff In terms of origin of raw materials i.e. plant and animal sources.
   - List the raw material sources
   - Describe some industries based on above.
   - Describe some industrial processes of Food preservation i.e. freezing, sterilization, curing, canning, drying etc.
   - Describe industries based on further processing of products above: bread, confectionary, beverages, margarine, dairy products etc.
   - List some common food additives.
   - Classify 1.6 above as colourants, flavours, preservatives, gelling and emulsifying agents, sweeteners etc.
   - Describe the significance of food additives.
   - List causes of food spoilage - bacterial, fugalvia insects and enzyme activity.
   - Describe ways of prevention of food spoilage (freezing, sterilization, drying etc.)
   - Explain the occurrence and significance of browning reactions
   - Describe the mechanism of browning reactions and distinguish between enzymic and non-enzymic browning in foods
   - Explain the various methods of controlling or inhibiting browning in foods, explain the occurrence of carbohydrates in plant foods
   - classify the different carbohydrates found in food
   - Explain the preparation of syrup from invert sugar
   - Explain the various types of polysaccharides - starch, cellulos, pectic substances, gums and mucilages and their significance in the food industry
   - Describe the use of carbohydrates as sweeteners and functional ingredients
- List the factors influencing the choice of sweetners in the confectionery industry
- List & explain the properties of starches and carbohydrates
- Explain the phenomenon of starch gelatinisation and retro gradation
- Explain the significance of starch gelatinisation and retro gradation in food processing
- List and explain the significant properties of amino acids and proteins
- Classify proteins found in plant and animal foods
- List the main limiting amino acids found in plant and animal foods
- Determination of proteins in food
- Explain the role of proteins in food processing
- List and classify naturally occurring lipids
- distinguish between fats and oils
- Explain the physical and chemical properties of edible fats and oils
- Explain the determination of fats and oils in foods
- Describe the processing of fats and oils into different foods products
- Explain the mechanism, causes of fat rancidity and its effect on food quality
- Explain the prevention and inhibition of fat rancidity in the food industry
- Explain the term reversion of fats and oil and its significance in the food industry
- Explain the importance of colour in the quality evaluation of foods
- Classify various colouring pigments found in food and list permitted colouring matter
- Describe the changes in food pigments during cooking and processing
- Describe the different methods of measuring colour of foods (Hunter, Munsell and CIE SYSTEMS)
- Explain the role of NAFDAC in regulating the food industry.
- List the quality control methods applicable to the industry as mostly in-process.

2. **Biotechnology of food**
   - Explain the meaning and origin of the term biotechnology
   - Explain the significance of biotechnology in the food industry
   - List and classify the major enzymes used in food and in the food industry
   - Explain the significance of the various classes of enzymes in the production of food products
   - Explain enzyme immobilization and its application in food industry
   - Explain the importance of enzymes in food analysis.

3. **Chemical principles and processes involved in beer brewing**
   - List raw materials use in brewing.
   - State why starch is the useful chemical constituent of the raw materials above.
- List local sources of starch for brewing.
- Describe methods of extraction of starch from the raw materials listed above.
- Explain how starch based glucose syrup is produced by the methods above.
- Define the term “fermentation”.
- List enzymes used in brewing.
- Explain how fermentation of glucose syrup leads to the production of beer.
- Describe limited and complete fermentation reactions.
- List industrial applications above.
- Describe commercial extraction, purification, storage and recovery of enzymes/yeast.
- Outline the processes of production of beer.
- Describe the chemical and biochemical techniques in the quality control of beer

❖ CMA243 : Introduction to Polymer Engineering

➢ Introduction to Polymer Engineering: 5 credits (75 hours); L, T, P, SPW

1. Detailed account of raw materials used;
2. Treatment of methods of polymerization and co-polymerization;
3. Principles of polymers formation;
4. Thermal cleavage of covalent bonds; radical production by photochemical; high energy radiation and oxidation-reduction processes;
5. Flow properties of polymers,
6. Classification of melt flow behavior, rheological properties,
7. Structure and properties of polymer; analysis and testing of polymers; production and properties of commercially important polymers;
8. Detailed account of polymer processing;
9. Design of equipment and machinery used;
10. Recent advances in polymer technology.

❖ CMA 244 : Chemical Wet Processing of Textiles

➢ Chemical Wet Processing of Textiles: 3 credits (45 hours); L, T, P, SPW

1. Chemistry of textile processing;
2. processes and machines for desizing, scouring, bleaching and mercerization.
3. Pretreatments; Application of reactive vat and another classes of dyestuff on various machines.
4. Dying of cotton, viscous rayon and blend fibres.
5. Printing, exposing print paste, pigment and reactive types.
6. Rotary printing machine on curing process.
7. Objective and service performance of chemical finishing of soft and hard finishing agents.
8. Printing flexibility using 55 CAD/CAM system;
9. Treatment of effluent from Textile Industry;
10. Recovery of chemicals and their sustainable aspects

❖ CMA 245 : Petrochemicals

➢ Petrochemicals: 4 credits: 60 hours; L, T, P, SPW
   1. Recent trends in Petrochemical industries.
   2. Hydrocarbon Sources and Raw materials: characterization, availability and pricing.
   3. Processes for the production of ethylene, acetylene, and other monomers.
   4. Polymerization of monomers into useful plastics.

❖ CMA 246: Professional internship

➢ Professional internship : 6 credits (90 hours); P, PW
   1. Arrival and integration in the enterprise
   2. Working in a company
   3. Holding of the Internship journal
   4. Choice of the theme of work in collaboration with the professional trainer and the academic supervisor
   5. Elaboration of the canvas of research
   6. Resources to exploit
   7. Organization of work
   8. Drafting of the report
   9. Presentation of the report before a jury

➢ Methodology of writing an internship report

   A. Drafting and structuring of probation report
    1. General Approach
       ▪ Nature and contents of internship report;
       ▪ Paragraph;
       ▪ The style and spelling.
    2. Structuring of the document
       ▪ Cover;
       ▪ Acknowledgments;
       ▪ Heading of the probation report;
       ▪ Executive Summary;
       ▪ List of figures and tables;
       ▪ Glossary;
       ▪ Body of the report of internship;
- Bibliography;
- Annexes;
- Summaries and keywords.

B. Formatting of the probation report

1. General information
   - Remission of the probationary report;
   - Choice of software.

2. Rules of presentation
   - Size of the probation report;
   - Page layout;
   - Families of fonts;
   - Sizes and styles of fonts;
   - Spacings and pagination.

3. Notes at the bottom of the page

4. Floaters
   - Tables;
   - Figures;
   - List of figures and tables;
   - Equations;
   - Glossary.

5. Bibliography
   - Purpose of the bibliographical quotations;
   - Format of bibliographical quotations; pop-up
   - List of bibliographical references;
   - Bibliographical references for electronic documents.

CMA 247: Accounting and Economics

- Accounting: 1 credit (15 hours); L, T, SPW

A. General Ledger

1. The Company and its heritage
   - Concept of the enterprise;
   - Balance sheet and its variations.

2. Analysis of the current operations of the company
   - Concept of jobs resources;
   - The Accounting transfer;
   - From accounts to balance.

3. The operations of purchases and sales
   - Billing;
   - Accounting registration;
   - System of inventory;
   - Stock form.
4. The regulations on term: the effects of trade
   - Definition;
   - Principles;
   - Calculations.
5. The depreciation and amortization
   - Definition;
   - Accounting registration;
   - Typology.

B. General introduction to the Financial Analysis
1. Analysis of the balance sheet
   - Summary presentation of the balance sheet.
2. Study of the structure of the balance sheet
   - Calculations of ratios.
3. Functional analysis of the balance sheet
   - Definition;
   - Principles;
   - Computations;
   - Table of differential exploitation.
4. Differential analysis of the balance sheet
   - Definition;
   - Principles;
   - Computations;
   - Table of differential exploitation.

C. Analytical management accounting
1. Generality on the cage
   - Objective;
   - Role;
   - Concept of burden.
2. Analysis of expenses
   - Liable burden
   - Direct and indirect expenses;
   - Valorization of stocks.
3. Method of full costs
   - Cost of purchase;
   - Cost of production;
   - Cost of returns;
   - Calculation of the result.

➢ Economics: 2 credits (30 hours); L, T, SPW
1. Notions of general economics
   - Introduction;
   - Consumption and production;
   - The raising of income;
• The currency and credit;
• The prices;
• The concept of growth and development.

2. **The Company**
• Introduction;
• Typology of enterprises;
• Structure and organization of the enterprise;
• The company and ethics;
• How to undertake (create, decide, manage).

3. **The place of the company in the economic fabric**
• Concept of the environment of the company;
• The inter- and extra-enterprises relationships;
• The commercial activity;
• The notion of strategy.

4. **The productive activity**
• The policies and processes of production;
• The trade policies;
• Logistics.

5. **The concept of management in the company**
• The activity and financial resources;
• The planning and management of human resources;
• The planning and the management of material resources.

6. **Information and Communication in the Enterprise**
• Role of information and communication;
• Collection and organization of information;
• Strategic diagnosis;
• Decision System
Field : CHEMICAL ENGINEERING

Specialty :

CHEMICAL PROCESS TECHNOLOGY
1. The objective of the training

This specialty has for objective to train senior technicians suited to the diverse and multiple trades related to the application of chemistry to the industry. They develop knowledge concerning the advancement, the sizing and the operating conditions which must ensure the management of the reactions industrial chemicals throughout their conduct.

2. Research Skills

→ **Generic Skills**
- Work independently, collaborate in a team;
- Comprehensively analyze and synthesize of a professional document (French, English);
- Communicate orally or in writing (French, English), within or out of a company or outside;
- Participate in / lead a project management process;
- Know and exploit the professional networks and institutional sectors of the chemistry.

→ **Specific skills**
- Control analytical tools applied to the processes;
- Grasp the problems of development: of the chemical act to the production;
- Size the devices of physical, chemical or biological transformations;
- Analyze, optimize and control the processes;
- Take into account the quality aspects, control of risk, security, sustainable development.

3. Career opportunities

- Research technician and testing on pilot facilities (development of new processes);
- Responsible for manufacture in traditional chemistry (mineral and organic), fine chemistry, pharmacy, cosmetics, refining, agri-food, bio-industries, thermal;
- Senior Technician to manufacture in the pharmaceutical industry
- Responsible for the environment (treatment of water, air, waste...);
- Engineer (designer in the field of study, assistance and Council...);
- Technico-commercial.
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course titles</th>
<th>Number of hours</th>
<th>Number Of Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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<tr>
<td>CPT111</td>
<td>Mathematics I</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>CPT112</td>
<td>Introduction to organic chemistry</td>
<td>50</td>
<td>15</td>
</tr>
</tbody>
</table>

| **Professional courses 60% (4 UC) 18 credits 270 hours** |                     |     |     |     |     |       |
| CPT113      | Structure of Matter I                             | 20  | 5   | 30  | 5   | 60   | 4     |
| CPT114      | Unit Operations I                                 | 20  | 5   | 45  | 5   | 75   | 5     |
| CPT115      | Chemical Thermodynamics I                         | 20  | 5   | 45  | 5   | 75   | 5     |
| CPT116      | Materials and laboratory techniques used in the industry | 20  | 5   | 30  | 5   | 60   | 4     |

| **Transversal Courses 10% (1 UC) 3 credits 45 hours** |                     |     |     |     |     |       |
| CPT117      | Bilingual Training                                | 30  | 5   | 5   | 5   | 45   | 3     |
| Total       |                                                   | 190 | 55  | 170 | 35  | 450  | 30    |

- **SECOND SEMESTER**

<table>
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<tr>
<td>CHI121</td>
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<tr>
<td>CHI122</td>
<td>Computer Science I</td>
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</table>

| **Professional courses 60% (4 UC) 18 credits 270 hours** |                     |     |     |     |     |       |
| CPT123      | Solution chemistry                                | 20  | 5   | 30  | 5   | 60   | 4     |
| CPT124      | Monofunctional Organic compounds                   | 20  | 5   | 45  | 5   | 75   | 5     |
| CPT125      | Process and industrial processes: Plan of Experience | 20  | 5   | 45  | 5   | 75   | 5     |
| CPT126      | Physicochemical Analysis I                         | 20  | 5   | 30  | 5   | 60   | 4     |

| **Transversal Courses 10% (1 UC) 3 credits 45 hours** |                     |     |     |     |     |       |
| CPT127      | Business Creation and civic and moral education    | 30  | 5   | 5   | 5   | 45   | 3     |
| Total       |                                                   | 190 | 55  | 170 | 35  | 450  | 30    |

*L*: lectures; *T*: tutorials; *P*: practicals; *SPW*: students’ personal work work
### THIRD SEMESTER

<table>
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<tr>
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<td>T</td>
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<tr>
<td>CPT231</td>
<td>Mathematics II</td>
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<tr>
<td>CPT232</td>
<td>Mineral chemistry</td>
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<tr>
<td>CPT233</td>
<td>Physicochemical Analysis II</td>
<td>20</td>
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<tr>
<td>CPT234</td>
<td>Relativity of polyfunctional compounds</td>
<td>20</td>
<td>5</td>
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<tr>
<td>CPT235</td>
<td>Chemical Thermodynamics II</td>
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<tr>
<td>CPT236</td>
<td>Chemical kinetics</td>
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<tr>
<td>CPT237</td>
<td>Methodology for the drafting of an IR</td>
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*L: lectures; T: tutorials; P: practicals; SPW: students’ personal work*

### FOURTH SEMESTER

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<th>Number Of Credits</th>
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<tbody>
<tr>
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<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
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<tr>
<td>CPT241</td>
<td>Physics II</td>
<td>30</td>
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<tr>
<td>CPT242</td>
<td>Computer Science II</td>
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<tr>
<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<tr>
<td>CPT243</td>
<td>Structure of Matter II</td>
<td>30</td>
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<tr>
<td>CPT244</td>
<td>Unit Operations II</td>
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<td>10</td>
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<td>CPT245</td>
<td>Spectroscopic methods Initiation to the synthesis</td>
<td>25</td>
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<tr>
<td>CPT246</td>
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<tr>
<td>CPT247</td>
<td>Accounting and Economics</td>
<td>30</td>
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<td><strong>Total</strong></td>
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</tbody>
</table>
5. Course content

❖ **CPT 111: Mathematics**

- Mathematics: 4 credits (60 hours); L, T, P, SPW
  1. Functions of a real variable
  2. Circular functions, hyperbolic and their reciprocal
  3. Differential of a function
  4. Differential equations
  5. Taylor's Formula and Limited Developments
  6. Simple integrals and applications
  7. Multiple integrals and applications to surface and volume calculation

❖ **CPT 112: Introduction to organic chemistry**

- Introduction to organic chemistry: 5 credits (75 hours); L, T, P, SPW
  1. Determination of a gross formula
  2. The carbon atom and its connections
  3. Isomerism
  4. Introduction to the stereochemistry: graphic representations of the molecules;
  5. Notions of conformation and configuration
  6. Conformational analysis
  7. Reactivity in organic chemistry
  8. Electronic effects in the Connections
  9. Tautomerism and its consequences
  10. Concept of reaction mechanism
  11. Reaction Intermediates
  12. Brønsted and Lewis Acid/base
  13. Relative nucleophiles, electrophiles
  14. Orientation of the reactions
  15. The solvents

❖ **CPT 113: Structure of Matter I**

- Structure of Matter I: 4 credits (60 hours); L, T, P, SPW
  1. The Atom
     - Its constituents;
     - The quantum model of the atom.
  2. Periodic classification of the elements from the quantum model of the Atom
     - Construction: historical and current classification;
     - Periodicity of atomic properties.
  3. The chemical bond
• The covalent binding;
• Exploitation of experimental data to determine;
• The electronic structure of molecules;
• Other strong interactions;
• Weak interactions.

4. The solid state
• Presentation of the crystalline state: networks, nodes, mesh, pattern, coordinence, compactness;
• The metal buildings:
  – Cubic network centered;
  – Compact assemblies: cubical sides centered
  – Compact hex;
  – Existence of interstitial sites tetrahedral and octahedral; - alloys for insertion and substitution:
    o Structure, examples;
    o The ionic buildings:
  – Description of the various types of structures: CsCl, NaCl, NAOS (blende), CaF2;
  – Relations between structural type and ionic radii in the case of compounds AB;
• The covalent buildings molecular and:
  – Carbon: diamond, graphite;
  – Molecular crystals: diode, carbon dioxide, ice.

❖ CPT 114: Unit Operations I

➢ Unit Operations I: 5 credits (75 hours); L, T, SPW

1. The distillation
  • Study of the vapor-liquid equilibria :
    – The case of binary ideal mixtures;
    – Cases of mixtures not ideals;
    – different types of distillation:
    – Simple distillation/ - instant distillation (flash);
    – correction;
    – Apparatus.

2. Extraction
  • General information;
  • The liquid-liquid extraction;
  • The solid-liquid extraction;
  • The extraction liquid-gas. Absorption and desorption.

3. Sedimentation - Filtration
  • Sedimentation;
  • Filtration.
4. **Techniques and various separations**
   - Storage and transport of solids;
   - In contact of a solid and a fluid;
   - Fragmentation of solids;
   - Solid separation-gas: dust removal;
   - Ion exchange;
   - processes to membrane;
   - formulation.

**CPT 115: Chemical Thermodynamics I**

- **Chemical Thermodynamics I:** 5 credits (75 hours); L, T, P, PW
  1. **The thermodynamic system**
     - Description of a closed system in chemical reaction: progress of the reaction;
     - Standard state of a pure component: magnitude standard molar.
  2. **Applications of the first principle**
     - Thermochemistry. Closed system headquarters of a physicochemical transformation;
     - The standard reaction of internal energy $\Delta rU^\circ$;
     - Standard enthalpy of reaction $\Delta rH^\circ$;
     - Standard enthalpy of formation $\Delta fH^\circ$;
     - Variation of these quantities with the temperature;
     - Flame temperature.
  3. **Application of the 2nd principle to the chemical reactions**

**CPT 116: Equipment and techniques of laboratories used in the industry**

- **Equipment and techniques of laboratories used in the industry:** 4 credits (60 hours); L, T, P, SPW
  Initiation, or revision, of the fundamental techniques of the Laboratory of organic and inorganic chemistry (distillation, crystallization extraction, control of physical constants, etc...).

**CPT 117: Bilingual training**

- **English:** 1.5 credits (22 hours 30mn)); L, T, SPW
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
4. Autonomous reading of "writings" of all levels
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
   - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. Write clear, detailed texts
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

French: 1.5 credits (22 hours 30mn)); L, T, SPW

1. Vocabulaire
   - Vocabulaire du matériel de technologie agro-alimentaire
   - Vocabulaire des produits agro-alimentaires
   - Vocabulaire des activités agro-alimentaires
   - Vocabulaire des actants
   - Vocabulaire des affaires

2. Grammaire
   - Du verbe: Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   - Des fonctions grammaticales.

3. Expression et communication
   - Compréhension et interaction au cours d’une discussion technique ;
   - Communication orale courante ;
   - Communication orale interactive ;
   - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
   - Lecture rapide et compréhension de texte ;
   - Synthèse de texte
   - De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
CPT 121: Physics I

Physics I: 4 credits (60 hours); L, T, P, SPW

1. Metrology
   - The International System of Units and the usual units;
   - equation to the dimensions and homogeneity of a relationship;
   - quality of a measurement:
     - Systematic errors, fidelity, accuracy, precision;
     - Resolution and Sensitivity of a measuring device;
     - Uncertainties on the result: statistical treatment of a series of measures; central tendency (Average, median);
     - Dispersion (gap-type, scope);
     - Confidence interval associated with a level of confidence;
     - In the case of a small sample size: Method of student;
     - method of the scope.
     - concept of quality control. The standard ISO 9000;
     - reminders and general information on the electrical regimes;
     - ongoing Drivers (metals, electrolytes, semi-conductors...):
       - nature of the bearers of burdens;
       - voltage and intensity of a current.
       - linear dipoles: Resistors (Joule effect, Ohm's law, laws of association);
       - the generators of voltage;
       - stack (equivalent model of thévenin: f.e.m., internal resistance).
   - The operating point. The a.o. in amplifier,
   - Search for a relationship between two sizes;
   - Linearization by change of mark, linear regressions or other, extrapolation and interpolation.

2. Thermodynamics
   - pressure in a fluid;
   - temperature:
     - Scales of temperatures at 1 or 2 points fixed;
     - Scale Celsius, absolute scale;
     - ladders practices.
   - Thermometers:
     - Thermometers for dilatation of liquid: their limits, their defects;
     - Electrical thermometers to resistance (platinum or semi-conductor);
     - Thermocouples;
     - Pyrometers: experimental finding of a relationship between the temperature of a body and: - on the one hand the total energy it
emits, on the other hand the spectral distribution of the emitted radiation, which leads to the two types of pyrometers (to total radiation and to monochromatic radiation).

- **Thermodynamic**:
  - Its universality;
  - Definition of the thermodynamic system and the external environment: Systems
  - Closed, opened, isolated. The status of the system, settings of state, equation of state. The variables extensive and intensive;
  - Transformations of the system: isobar, isochore, isotherm, adiabatic; - exchanges between the system and the external environment: work, heat, subject; - Conventions of sign.

- The first principle of thermodynamics: its character of conservation; calorimetry real gas:
  - insulated curves;
  - critical point.

- The model of perfect gases;

- Energy study of gases considered as the perfect;

- The second principle: its character not conservative (creation of entropy):
  - The transformations and reversible and irreversible;
  - Statement of the second principle: definition of the entropy;
  - Simple examples of variation of the entropy in the spontaneous phenomena;
  - Definition of free energy and free enthalpy.

- The third principle:
  - Definition;
  - Entropy of a pure body to the zero K;
  - Postulate of Nernst;
  - Calculation of the absolute entropies;
  - Utilities and uses of the tables of thermodynamic data.

- Changes of Phase of pure body: General Study:
  - Rule of phases;
  - Diagram of balance: triple point, areas of stability of phases;
  - Relationship of Clapeyron;
  - Delay to changes in phase;
  - The tables of entropy and enthalpy of pure body; - state diagrams: curves LNP(h), S(t), H(s).

- Thermal machines and motors:
  - Carnot theorem. Thermal engines;
  - Refrigerating machines;
  - Theoretical efficiency;
  - Heat pumps;
  - Effectiveness theoretical.
3. The phenomena of interface
   - Interface pure liquid-gas:
     - Experimental evidence (liquid blades, drops, menisci, capillary rise;
     - Etc...). Origin of phenomena: interactions of van der Waals type;
     - their radius of action;
     - Definitions: surface tension, free energy of surface;
     - Influence of the pressure and the temperature;
     - Properties of the Curves interfaces;
     - Laplace equation in the case of a spherical structure.
   - Liquid-solid interface:
     - Phenomenon of mooring: angle of connection, condition of Young;
     - Capillary ascent: law of Jurin;
   - Surface tension of aqueous solutions:
     - Surfactants compounds: molecular structure;
     - Distribution In the surface of the surfactant;
     - Law of Szyskowski;
     - Gibbs Isotherm.
   - Methods for the measurement of surface and interfacial tension:
     - Using the capillary rise and/or horizontal capillary;
     - Methods of tearing;
     - Methods of the drooping drops (Act approached of Tate);
     - Method of the sessile drop;
     - Method of the pressure of maximum bubble.
   - Electrical phenomena to interfaces:
     - Between Potential phases: Galvani, Volta and surface;
     - Electrical Double Layer: potential of distribution (electrodes,
       membranes, between liquids immiscible);
     - Potential for adsorption;
     - The electrokinetic phenomena: electro-osmosis;
     - potential for flow;
     - Electrophoresis.

CPT 122: Computer Science I

- Computer Science I: 5 credits (75 hours); L, T, P, PW
  1. Use of software tools
     - The presentation will be done with a software on the market. It is not to
       train the students to a product but of their present the major features
       of a type of product studied.
  2. Spreadsheet
     - Concept of cell (content, references of the absolute and relative).
     - Name of a cell or an area of cells.
     - Filling a cell (text, numbers, formula, function, generation of values).
     - The copy of the contents of a cell.
1. Creation of graphs.
2. Put in the form of a table of values and/or of its graphic representation.
3. Use of a solver or optimizer.

3. Treatment of texts
   - Techniques of treatment of text.
   - Put in the form of titles and paragraphs creation of new styles.
   - Automatic page numbering and titles.
   - Creation of a summary.
   - Use of a publisher of equations and/or a tool allowing the seizure of mathematical formulas.
   - Inserting Tables, graphs from a spreadsheet.
   - Insertion of drawings and diagrams.

4. Database
5. The plans of Experience
6. Between the analogue and digital

❖ CPT 123: Solution chemistry

❖ Solution chemistry: 4 Credits (60 hours); L, T, P, SPW
1. The water
   - Relative permittivity, conductivity, ionization;
   - Structure and mobility of the hydrated proton;
   - Autoprotolysis water, ionic product;
   - Solvation and solvolysis;
   - Strong electrolyte, low electrolyte.
2. Acid-base reactions (formulation of Brönsted)
   - Definition of acids and bases;
   - Calculation of the pH of aqueous solutions;
   - Buffer solutions.
3. Precipitation Reactions
   - Solubility and solubility product;
   - Condition of precipitation;
   - The common ion effect;
   - Influence of pH on solubility.
4. Complexation reactions:
   - Stability of the complex;
   - Complexations competitive;
   - Complex and precipitation;
   - Complex and pH.
5. Redox Reactions
   - Redox Couple: definition, redox potential standard, formula of Nernst;
   - Anticipation qualitative and quantitative reactions;
   - Determination of the equilibrium constants;
- Redox - reduction and pH: conditional diagrams potential- pH; Redox - reduction and complexation: - Potential Diagrams-PL; Redox - reduction and precipitation: potential Diagrams-PX.

**CPT 124: Monofunctional Organic**

- **Monofunctional Organic Compounds**: 5 Credits (75 hours); L, T, P, SPW
  1. Reactivity of hydrocarbons and monofunctional compounds
  2. Alkanes, Alkenes
     - Electrophilic addition;
     - Other additions;
     - The oxidations;
     - Allylic substitution.
  3. The Alkynes
     - Additions;
     - Properties of true alkynes.
  4. Aromatic compounds
     - Concept of aromaticity;
     - Electrophilic substitution;
     - Reactions of the side chain;
     - Additions;
     - Birch Reduction;
     - The oxidations of cycle;
     - Heterocyclic aromatic character.
  5. Halogenated derivatives
     - Nucleophilic substitution;
     - Elimination Reactions;
     - Action of metals and of silicon;
     - Ethylenic halides.
  6. Organometallics
     - Mixed magnesium organic compounds;
     - Constitution;
     - Basic properties;
     - Nucleophilic properties;
     - Other organometallics.
  7. Alcohols
     - Acid-base properties;
     - nucleophilic properties;
     - The oxidations; dehydrogenation.
  8. Phenols
     - Acidity;
     - Electrophilic substitution;
     - Nucleophilic properties;
     - Condensation reactions;
     - Oxido-reduction.
9. **Epoxydes and ethers-oxides**
   - Opening of the cycle of the epoxides;
   - Nucleophilic properties of ethers-oxides;
   - Reaction due to the α-hydrogen of ether-oxides.

10. **Aliphatic amines**
   - Basic properties;
   - Nucleophilic properties;
   - Ammonium ions Quaternary.

11. **Aromatic amines**:
   - Basic properties;
   - Electrophilic substitution;
   - Nucleophilic properties;
   - Oxidations.

12. **Diazoiques**
   - Reactions with departure of nitrogen;
   - Reactions without departure of nitrogen;
   - Diazomethane.

13. **Aldehydes Ketones**
   - The nucleophilic addition to the carbonyl;
   - Reactions to the α-hydrogen;
   - Aromatic aldehydes;
   - Conjugated ketones;
   - Redox reactions.

14. **Carboxylic acids**
   - Acid properties;
   - Conversion to derivatives of acids;
   - Halogenation in α;
   - Conversion to carbonyl derivatives;
   - Reduction.

15. **Derivatives of acids**
   - The chlorides;
   - Anhydrides, esters, amides, nitriles;
   - Degradation of Hofmann amides;
   - Reactions due to the mobility of α-hydrogen atom of the carbonyl group of esters and nitriles.

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**CPT 125: Process and industrial processes: Plan of Experience**

- **Process and industrial processes: Plan of Experience**: 5 credits (75 hours); L, T
  1. Diagram of the process and regulation
  2. Method of balance sheets - The reactors
  3. Movement of fluids
  4. Heat transfer - production of heat and cold
  5. Evaporation - crystallization drying unto
CPT 126: Physicochemical analysis I

- Physicochemical analysis I: 4 credits (60 hours); L, T, P, SPW
  1. Acid/base titrations
     - Use of indicators;
     - pH metry;
     - Conductivity.
  2. Precipitation titrations
     - Gravimetry;
     - Volumetry: methods of Mohr and Charpentier volhard;
     - Potentiometry (i = 0); conductivity.
  3. Complexation titration
     - Use of EDTA (with indicator):
     - Direct titrations;
     - Back titrations;
     - Substitution titrations.
  4. Redox titrations
     - Use of indicators;
     - Potentiometry (i = 0);
     - Manganimetry;
     - Iodometry;
     - Chromimetry.
  5. Spectrophotometric quantification by molecular absorption (UV, visible)
     - Route of absorption spectra;
     - Strengths: method of the calibration range.
  6. Determination by atomic absorption spectrophotometry, and atomic emission
  7. Analytical properties of ions in aqueous solution
     - Examples will be chosen from among the ions encountered in quantitative analysis and mineral chemistry.

CPT 127: Computer Science Training/ Entrepreneurship

- Computer science training: 2 credits (30 hours); L, T, P, SPW
  Computer structure, introduction to some basic computer software’s (World, Office, Excel, SPSS, Epi Info, Matlab), using computer software for data analysis, information and data transfer, storage and security, using internet and social networks, examples of applications.

- Entrepreneurship: 1 credits (15 hours); L, T, SPW
  1. Concept of an entrepreneur
  2. Motivations in the creation of a business
  3. Search for ideas and evaluation
4. Search for funding
5. Choice of legal status
6. Ethical aspects of business

❖ CPT 231: Mathematics II

➢ Mathematics II: 4 credits (60 hours); L, T, SPW
1. Numerical sequences
2. Numerical series
3. The Fourier series
4. Laplace transformation
5. Fourier transform
6. Functions with several variables - scalar fields and vectors and a few applications

❖ CPT 232: Mineral chemistry

➢ Mineral chemistry: 5 credits (75 hours); L, T, P, SPW
1. Oxygen
   - Study of oxygen molecule;
   - Reactivity of the oxygen gas;
   - Study of oxides;
   - Structural classification;
   - Evolution of acid/base character;
   - Stability and reduction: diagram of Ellingham.
2. Chlorine
   - Study of chlorine molecule;
   - Reactivity of chlorine gas;
   - Study of chlorine in aqueous solution: the exploitation of the potential diagram-pH.
   - Industrial Preparation of chlorine; - Evolution of the properties of halogens;
   - physical properties of atoms, molecules ofX2, and HX;
   - Redox properties of X2in aqueous solution.
3. Ammonia and nitric acid
   - ammonia;
   - nitric acid.
4. Sulfuric acid
   - Industrial preparation, industrial importance;
   - ACID properties and oxidising properties.
5. A few metals, alloys, materials
   - General information on the metals;
   - Uranium;
   - Iron
CPT 233: Physicochemical analysis II

- Physicochemical analysis II: 4 credits (60 hours); L, T, P, SPW
  1. Electrochemical Methods
  2. Optical Methods: spectrophotometry of molecular absorption
  3. Chromatography on ion exchange resins
  4. Specific techniques
  5. Quantification of organic substances: study of kinetics of reactions
determination of thermodynamic constants

CPT 234: Relativity of polyfunctional compounds

- Relativity of polyfunctional compounds: 5 credits (75 hours); L, T, P, SPW
  1. Conjugated dienes
     ▪ Electrophilic addition 1,2 and 1,4;
     ▪ Synthesis of Diels-Alder.
  2. The diols
     ▪ Dehydration;
     ▪ The oxidations;
     ▪ Protection of the carbonyl group.
  3. Dicarbonyl compounds
     ▪ Compounds 1,2;
     ▪ Dicarbonyl compounds;
     ▪ Compounds 1,3;
     ▪ Dicarbonyl compounds.
  4. Diacids
     ▪ Acid properties;
     ▪ Dehydration and decarboxylation;
     ▪ Malonic esters.
  5. Applications
  6. Macromolecular materials
     ▪ Polymerization by addition;
     ▪ Polymerization by condensation;
     ▪ Relations structure-properties;
     ▪ Plastics; degradation products.
  7. Compounds of biological interest
     ▪ Amino acids;
     ▪ Polypeptides;
     ▪ Proteins: acid-base properties;
     ▪ Stereochemistry of natural amino acids;
     ▪ Peptide bonds;
     ▪ Stereochemistry of proteins;
     ▪ Biological interest;
     ▪ Carbohydrates: presentation of the main families;
- Anomérie: biological interest;
- Lipids: classification.

8. Uses in the biological fields, food and industrial.

**CPT 235: Chemical Thermodynamics II**

- **Chemical Thermodynamics II: 5 credits (75 hours); L, T, P, SPW**
  1. **Criterion of spontaneous evolution of a system**
     - Entropy of reaction $\Delta rS$;
     - Variation of this magnitude with temperature;
     - Chemical potential;
     - Free enthalpy of reaction $\Delta rG$;
     - Expression in function of the product $\pi \Delta rG = \Delta rG^0 + RT \ln \pi$.
  2. **Chemical equilibrium**
     - Condition of balance;
     - Thermodynamic constant $K(t)$;
     - Variation of $K^0$ with the temperature;
     - Relationship of Van't Hoff;
     - Determination of composition of a system
     - displacement of equilibrium;
     - Variance.

**CPT 236: Chemical Kinetics: 4 credits (60 hours); L, T, P, SPW**

- **Chemical Kinetics: 4 credits (60 hours); L, T, P, SPW**
  1. General definition of the speed of a chemical reaction in the case of a closed reactor and of uniform composition: rates of disappearance and formation of a grantor, overall speed of reaction.
  2. Influence of concentrations on the speed of a reaction;
     - Order of reaction;
     - Experimental methods of determination.
  3. **Study of a few types of reaction**
     - Total reactions of order 0, 1, and 2 (any proportions);
     - The reactions of order 1 giving rise to a chemical equilibrium;
     - Successive reactions of order 1;
     - Parallel reactions of order 1.
  4. **Influence of temperature**
     - Energy of activation.
  5. **The concepts of reaction mechanisms in homogeneous kinetics**
     - Molecularity;
     - Basic Process: the reaction intermediates, transition state;
     - Approximation to the State quasi-stationary;
     - Approximation to the rate-determining step;
     - Application to the verification of reaction mechanisms, Hammond postulate, controls, kinetics and thermodynamics.
  6. **Homogeneous and heterogeneous Catalysis**
CPT 237: Civic Education and Ethics/ Initiation to the Law

- Civic Education and Ethics : 1.5 credits (22 hours 30 min);
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property unto collective's goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem;
  - Management and ethics of responsibility;
  - Ethics and management.
  - Codes of ethics
  - Civics
  - Deontology
  - Moral consciousness
  - The universal declaration of Human Rights
  - Good governance in public services
  - Explain the importance of civics to the life of the nation
  - Functions of the state and its citizens
  - Deontology, Professional ethics and professionalism
  - Protection of the environment
  - Some moral figures through national and foreign history

- Initiation to the Law : 1.5 credits (22 hours 30 min);
Objective: At the end of this course, students should be able to identify and explain some fundamental principles of business law, distribution law, labour law and intellectual property law. Students are equally expected to understand the rules and legal provisions regarding the internal and external operations of a corporate body including the powers of executive.

Courses Content
1. Business Law;
2. Distribution Law;
3. Labour Law;

CPT 241: Physics II: 4 Credits (60 hours); L, T, P, SPW

- Physics II : 4 Credits (60 hours); L, T, P, SPW
  1. Viscosity of fluids: introduction to the rheology.
     - Notions of rheology;
     - Definitions of the coefficients of viscosity;
- The influence of different parameters on the viscosity;
- Rheological behavior and classification of fluids;
- Methods of measurement of viscosity.

2. **Spectrometry of particles**
   - Field and electric potential;
   - Magnetic field;
   - Magnetized environments;
   - Radioactive transformations.

3. **Spectrometry of electromagnetic radiation.**
   - General information on the waves;
   - Wave nature of light;
   - Study of the sources of electromagnetic radiation;
   - Geometrical optics approximation;
   - Dispersive systems to network;
   - Light sensors;
   - Spectroscopic methods.

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**CPT 242: Computer Science II**

- **Computer Science II: 4 credits (60 hours); L, T, P, SPW**
  1. **Introduction**
  2. **Fundamental elements**
     - Problem and the algorithm;
     - Program and programming language;
     - From problem to the solution by computer;
     - Programming paradigms.
  3. **Concepts of programming in C++**
     - Presentation and description of the programming language;
     - Structuring of a program;
     - Descriptions of the data, actions;
     - Style of programming.

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**CPT 243: Structure of Matter II**

- **Structure of Matter II: 4 credits (60 hours); L, T, P, SPW**

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**CPT 244: Unit Operations II: 4 credits (60 hours); L, T, P, SPW**

- **Unit Operations II: 4 credits (60 hours); L, T, P, SPW**
CPT 245: Spectroscopic methods and initiation to synthesis

Spectroscopic methods and initiation to synthesis: 4 credits (60 hours); L, T, P, SPW

The theoretical study is limited to the minimum necessary for the exploitation of correct spectra, this in addition to the theoretical concepts studied in other disciplines. The study of the Spectra will give rise to the use of software and data banks; Mass spectrometry; IR spectroscopy; NMR spectroscopy; spectroscopy UV-visible; Application to the determination of the structures. It will illustrate to the laboratory scale the major reactions of organic chemistry, linking them to the large unit operations in the organic industry. We will begin by simple reactions and summarize to a single step, the aim should be in the course of the curriculum, to arrive at the realization of preparations in several stages. It will highlight methods to protect a functional grouping. The operations directed at the beginning, will need to evolve gradually toward greater autonomy, including: bibliographic research; the choice of equipment and reagents; the calculation of the quantities implemented; proposals for variation of parameters to optimize the results (can be on this subject briefly mention the plans of experience); the proposal and implementation of methods of control of the raw materials and products.

CPT 246: Professional internship

Professional internship: 6 credits (90 hours); P, PW

1. Arrival and integration in the enterprise
2. Working in a company
3. Holding of the Internship journal
4. Choice of the theme of work in collaboration with the professional trainer and the academic supervisor
5. Elaboration of the canvas of research
6. Resources to exploit
7. Organization of work
8. Drafting of the report
9. Presentation of the report before a jury

Methodology of writing an internship report

A. Drafting and structuring of probation report
1. General Approach
   ▪ Nature and contents of internship report;
   ▪ Paragraph;
   ▪ The style and spelling.
2. Structuring of the document
   ▪ Cover;
   ▪ Acknowledgments;
B. Formatting of the probation report

1. General information
   - Remission of the probationary report;
   - Choice of software.

2. Rules of presentation
   - Size of the probation report;
   - Page layout;
   - Families of fonts;
   - Sizes and styles of fonts;
   - Spacings and pagination.

3. Notes at the bottom of the page

4. Floaters
   - Tables;
   - Figures;
   - List of figures and tables;
   - Equations;
   - Glossary.

5. Bibliography
   - Purpose of the bibliographical quotations;
   - Format of bibliographical quotations; pop-up
   - List of bibliographical references;
   - Bibliographical references for electronic documents.

CPT 247: Accounting and Economics

- Accounting: 1 credit (15 hours); L, T, SPW

A. General Ledger

1. The Company and its heritage
   - Concept of the enterprise;
   - Balance sheet and its variations.

2. Analysis of the current operations of the company
   - Concept of jobs resources;
   - The Accounting transfer;
   - From accounts to balance.

3. The operations of purchases and sales
   - Billing;
   - Accounting registration;
4. The regulations on term: the effects of trade
   - Definition;
   - Principles;
   - Calculations.

5. The depreciation and amortization
   - Definition;
   - Accounting registration;
   - Typology.

B. General introduction to the Financial Analysis

1. Analysis of the balance sheet
   - Summary presentation of the balance sheet.

2. Study of the structure of the balance sheet
   - Calculations of ratios.

3. Functional analysis of the balance sheet
   - Definition;
   - Principles;
   - Computations;
   - Table of differential exploitation.

4. Differential analysis of the balance sheet
   - Definition;
   - Principles;
   - Computations;
   - Table of differential exploitation.

C. Analytical management accounting

1. Generality on the cage
   - Objective;
   - Role;
   - Concept of burden.

2. Analysis of expenses
   - Liable burden
   - Direct and indirect expenses;
   - Valorization of stocks.

3. Method of full costs
   - Cost of purchase;
   - Cost of production;
   - Cost of returns;
   - Calculation of the result.

- Economics: 2 credits (30 hours); L, T, SPW

1. Notions of general economics
   - Introduction;
• Consumption and production;
• The raising of income;
• The currency and credit;
• The prices;
• The concept of growth and development.

2. The Company
• Introduction;
• Typology of enterprises;
• Structure and organization of the enterprise;
• The company and ethics;
• How to undertake (create, decide, manage).

3. The place of the company in the economic fabric
• Concept of the environment of the company;
• The inter- and extra-enterprises relationships;
• The commercial activity;
• The notion of strategy.

4. The productive activity
• The policies and processes of production;
• The trade policies;
• Logistics.

5. The concept of management in the company
• The activity and financial resources;
• The planning and management of human resources;
• The planning and the management of material resources.

6. Information and Communication in the Enterprise
• Role of information and communication;
• Collection and organization of information;
• Strategic diagnosis;
• Decision System
Field : CHEMICAL ENGINEERING

Specialty :

CHEMICAL LABORATORY TECHNOLOGY
1. The objective of the training

The Higher National Diploma Programme in Chemistry Laboratory technology is designed to produce technologists capable of carrying out various laboratory analysis and practical works independently, specifically to:

- Carry out chemical analysis and quality control in: industry (oil, food, brewing, detergent, textiles, etc.), hospitals, schools, colleges and research institutions;
- Carry out general chemical work in industrial and academic laboratories;
- Assist in biochemical analysis and experiments in hospitals, schools, colleges and research institutes;
- Prepare students for employment in related work such as sales, marketing, administration and management in the industries and also, for self-employment.

2. Research Skills

→ Generic Skills

- Work independently, collaborate in a team;
- Comprehensively analyze and synthesize of a professional document (French, English);
- Communicate orally or in writing (French, English), within or out of a company or outside;
- Participate in / lead a project management process;
- Know and exploit the professional and institutional networks of agricultural biotechnology sectors.

→ Specific Skills

- perform basic lab operations (weighing, measuring, heating, ...);
- use conventional and modern procedures for the quantitative analysis and synthesis of organic and inorganic compounds;
- be proficient in standard techniques used in industry;
- use qualitative and quantitative methods to analyze samples in the biotechnology area;
- be an expert in compiling and processing laboratory;
- Fabricate commercialized products.
3. Career opportunities

Work with government agencies, industries, university laboratories and consulting firms on a range of projects of quality control for research and development. Supervise in the field of, chemistry, biology or engineering technology.
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
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<th>Course titles</th>
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<td>CLT111</td>
<td>Laboratory Management</td>
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</tr>
<tr>
<td>CLT112</td>
<td>General Instrumentation</td>
<td>20</td>
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</table>

**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

- CLT113: Inorganic Chemistry I
  - L: 25, T: 15, P: 30, SPW: 5, Total: 75, 5 credits
- CLT114: Physical Chemistry I
  - L: 25, T: 15, P: 30, SPW: 5, Total: 75, 5 credits
- CLT115: Organic Chemistry I
  - L: 25, T: 10, P: 20, SPW: 5, Total: 60, 4 credits
- CLT116: Analytical Chemistry I
  - L: 25, T: 10, P: 20, SPW: 5, Total: 60, 4 credits

**Professional courses 60% (4 UC) 18 credits 270 hours**

- CLT117: Bilingual training
  - L: 20, T: 10, P: 10, SPW: 5, Total: 45, 3 credits

**Total**


- **SECOND SEMESTER**

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<td>CLT121</td>
<td>Biochemistry for Chemists</td>
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<tr>
<td>CLT122</td>
<td>Biological and Chemical Instrumentation</td>
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**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

- CLT123: Polyfunctional Compounds
  - L: 30, T: 15, P: 30, SPW: 5, Total: 75, 5 credits
- CLT124: Chemical Kinetics
  - L: 30, T: 10, P: 30, SPW: 5, Total: 75, 5 credits
- CLT125: Industrial Chemistry
  - L: 20, T: 10, P: 25, SPW: 5, Total: 60, 4 credits
- CLT126: Chemical Analytical Technics
  - L: 20, T: 10, P: 25, SPW: 5, Total: 60, 4 credits

**Professional courses 60% (4 UC) 18 credits 270 hours**

- CLT127: Computer science and Entrepreneurship
  - L: 25, T: 10, P: 5, SPW: 5, Total: 45, 3 credits

**Total**

- L: 175, T: 85, P: 160, SPW: 35, Total: 450, 30 credits

L: lectures; T: tutorials; P: practicals; SPW: students' personal work
### THIRD SEMESTER

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<td>CLT231</td>
<td>Computer Applications in Chemistry</td>
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<td>Petroleum and Petrochemicals</td>
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<td>CLT233</td>
<td>Inorganic Chemistry II</td>
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<td>CLT234</td>
<td>Chemical Thermodynamics</td>
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<td>CLT235</td>
<td>Organic and Heterocyclic Chemistry</td>
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<td>Analytical Chemistry II</td>
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### FOURTH SEMESTER

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<tr>
<td>CLT 241</td>
<td>Forensic Biochemistry</td>
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<td>CLT 242</td>
<td>Food Chemistry and Brewing</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<td>CLT 244</td>
<td>Electrochemistry and Photochemistry</td>
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<td>CLT 245</td>
<td>Natural Products and Stereochemistry</td>
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<td>CLT 247</td>
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</table>
5. Course content

**CLT 111: Laboratory Management**

- **Laboratory Management**: 5 Credits (75 hours); L, T, P, SPW

**General objectives:**
- Know types of laboratories, their furnishings and fittings
- Understand the laboratory layout
- Understand the principles of designing laboratory stores
- Understand the management of stores
- Understand the principles of store keeping
- Know the acquisition, storage and use of technical informations
- Understand record keeping in the laboratory
- Understand the importance of discipline in the laboratory
- Understand routine administrative function in the laboratory

**Content:**

1. **Types of laboratories, their furnishings and fittings**
   - Explain the term ‘laboratory’.
   - Types and features of laboratories
   - Explain the factors to be considered when designing a laboratory
   - Draw sketches of typical laboratory layout.
   - Identify laboratory furniture, giving reasons for material choice
   - List suitable materials for the laboratory
   - List essential laboratory fittings and importance

2. **The laboratory layout**
   - Describe the dimension of a standard laboratory work bench, specifying width, length, height and spacing, and types of arrangement
   - Describe the services and fittings, obtainable on laboratory bench tops.
   - Describe and explain the importance of the methods of providing lighting and ventilation in a laboratory.
   - Describe methods of evaluating illumination and efficiency of light fittings in a laboratory.
   - Explain the importance of lighting and ventilation in a laboratory.
   - Draw the layout of a typical laboratory, showing the essential services.

3. **The principles of designing laboratory stores**
   - List the factors that should be considered in the design of a laboratory store
   - Explain the importance of factors in above.
   - Draw the layout of a typical laboratory store.
   - Describe the correct sitting of a balance room in the laboratory
   - List the essential features of a balance room
- Explain and illustrate the effect of vibration, temperature and dust on balance, and how it can be minimized.
- Describe methods of transporting and installing mercury barometers.
- Describe the effect of vibration on galvanometers and how it can be minimized.
- List the types of laboratory distillers and de-ionisers and their uses.
- Describe the methods of installing distillers and de-ionisers as in above.

4. **The management of stores**
   - List types of stores and their features.
   - Explain the activities that take place in the stores listed in above.
   - Explain the importance of the features stated in above.

5. **The principles of store keeping**
   - Explain the functions of store keeper.
   - Explain the legal liabilities of the storekeeper.
   - Explain the use of his/store cards inventory.
   - Explain government regulations relating to import.
   - Outline the procedure for the purchase of various materials for the store.
   - Identify the various types of documents for ordering receiving and paying for goods.
   - Explain the importance of the documents listed above.

6. **The acquisition, storage and use of technical informations**
   - List sources of information and their importance for the laboratory.
   - Describe different methods of storing technical information.
   - Explain the methods of retrieving, technical information.
   - Describe how to store and retrieve technical information for the laboratory.
   - Explain the use of technical information sources.

7. **Record keeping in the laboratory**
   - List types of laboratory records and explain the importance.
   - Explain the importance of each type of record.

8. **The importance of discipline in the laboratory**
   - Explain the significance of hierarchy in staff structure.
   - Explain the need for discipline in the laboratory environment.
   - Explain qualities of leadership and good example as a basis for disciplinary practices.
   - Evaluate methods of appreciation and criticism as they relate to.
   - Describe the methods of achieving good communication between staff and students.
   - Explain the importance of a good student/staff relationship.

9. **Understand routine administrative function in the laboratory**
   - List the minimum staff strength in the laboratory.
   - Explain the importance of good/poor staffing.
   - Determine the optimal staff/student ratio in a typical laboratory.
   - List basic staff of a laboratory.
- List factors to be considered for asking at interviews for laboratory staff.
- Explain how the factor listed in 10.5 above can be used in interviews for laboratory staff

**CLT 112: General Instrumentation**

- **General Instrumentation: 4 credits (60 hours); L, T, P, SPW**

**General objectives:**
- Understand the operation, use and care of basic measuring instruments
- Know the types of signal generators in the laboratory
- Know the types of pressure measuring instruments
- Know the types of recorders and reproducers
- Know the types of power supply units in the laboratory
- Understand the essentials of trouble-shooting techniques

**Content:**

1. **The operation, use and care of basic measuring instruments**
   - Identify basic measuring instruments
   - Classify, with examples, measuring instruments.
   - Describe the principle of operation with precautions to be taken when using the instruments in above.
   - Describe with the aid of diagrams the construction of instruments in above.
   - Explain the terms: Multimeter; Multirange; Autoranging
   - Carry out set-zero and calibration adjustments in the instruments in above.
   - Measure: Voltage; Current; Resistance using the appropriate instrument in above. Weights, temperatures
   - Measure frequency, amplitude, phase relationship of signals by using oscilloscope
   - Construct measuring instruments
   - Carry out measurements using the instruments in above.
   - Carry out routine care of the instruments in above.

2. **The types of signal generators in the laboratory**
   - Classify signal generators
   - State the different types of waveforms produced by signal generators in above
   - Describe with the aid of suitable diagrams the operation of the signal generator listed in above.
   - Describe a typical application of each type of signal generator listed in above.
   - State the use of a signal generator in fault-finding, etc.

3. **The types of pressure-measuring instruments**
   - Identify the different types of instruments used in measuring pressure
   - Classify the instruments in above in relation to their operating principles.
• Describe the principle of operation of some pressure measuring instruments in above.
• Measure pressure using any of the instruments in above.

4. The types of recorders and reproducers
• Identify the different types of recorders and reproducers
• Describe the principle of operation of the recorders and reproducers commonly used in the laboratory.
• Describe typical applications of the recorders and reproducers in above.
• Describe routine care of the recorders and reproducers in above

5. The types of power supply units in the laboratory
• Identify types of power supply unit
• Classify direct current supply
• Explain with the aid of diagrams how a.c. is converted to d.c.
• Describe the construction of typical power supply units.
• Outline the precautions to be observed when using power supply units.
• Describe the application of power supply units and their limitations

6. The essentials of trouble-shooting techniques
• Identify tools for trouble-shooting
• Obtain necessary information from the operator and from service manuals about a given instrument.
• Check: (a) Continuity (b) Availability of power etc. in the instruments in above.
• Trouble-shoot instruments such as overhead projector, PH meter etc.
• Detect defective modules or pants in instruments using the tools in above.
• Repair or replace the defective module pants in above.

CLT 113: Inorganic Chemistry I

Inorganic Chemistry I: 5 credits (75 hours); L, T, P, SPW

1. The relationship between the electronic structures and properties of the d- and f- block elements
• Outline the general properties of the d- block elements.
• Occurrence and isolation
• Close packing concepts
• Metallic bonding
• Band theory
• Conductivity
• High oxidation states
• Intermediate oxidation states
• Metal-metal bonded d-metal Compounds
• Noble character of group 12 elements
• Metal Sulphides and Sulphide complexes
Write the electron configurations of the following groups of the d-block elements: Sc, Ti, V, Cr, Mn, Fe, Mo.

Explain the peculiar properties of the following transition metal groups listed above.

Relate properties of the group 12 elements to electronic structure.

Explain the functions and uses of d-block elements and their compounds.

Explain the nature of the f-block elements (lanthanides and actinides).

Write the electronic configuration of some representative f-block elements.

Compare the electronic configuration of d-block with those of f-block elements.

Outline the uses of Lanthanides and Actinides.

Explain the phenomenon of artificial radioactivity.

2. **The chemistry of co-ordination compounds d- and f-block elements**

   Explain the meaning of Coordination Compounds.

   Illustrate the shape and disposition of d-orbitals with diagrams.

   Define effective atomic number in relation to:
   - Co-ordination numbers
   - Ligands
   - Number of electrons lost and gained during bonding.

   Explain Alfred Werner theory.

   Describe the various isomeric forms viz: geometric and optical isomerism, polymerization isomerism, ionization isomerism, Hydrate isomerism, linkage isomerism, coordination isomerism.

   Apply the I.U.P.A.C system of nomenclature in naming co-ordination compounds.

   Illustrate the various structural arrangements possible in coordination compounds such as:
   - Octahedral complexes
   - Square planner complexes
   - Tetrahedral complexes

   Explain the degenerate nature of the d-orbital in an atom.

   Explain the splitting of the dorbital under the influence of ligand field for octahedral, tetrahedral and square planar complexes.

   Describe the effect of the lig and field on the orbital electrons in the formation of:-
   - spin free outer orbital complex
   - spin paired inner orbital complex. co-ordination equilibria

   Know rates and mechanisms of lig and substitution.

   Illustrate the different degrees of stability of various oxidation states.

3. **Selected examples of the bioinorganic chemistry of d-and f-block compounds**

   Explain biological roles of some metal ions.
Explain the roles of Fe complexes and Cu complexes in biological oxygen transport
Describe models of oxygen binding based on Co and Fe synthetic complexes
Know the structure of Vitamin B12
Describe the structure of the active site of zinc-containing carboxypeptidase enzymes
Describe the role of the zinc ion in the mechanism of action of the carboxypeptidases
Know the structure and mechanism of action of the anticancer drug cis-platin

CLT 114: Physical Chemistry I

- Physical Chemistry I: 5 credits (75 hours): L, T, P, SPW

1. Types, properties and use of colloids understands the principles and applications of phase equilibria.
   - Define Colloid.
   - Classify colloids as Lyophilic or lyophobic.
   - Explain the differences between lyophilic and lyophobic sols.
   - Describe the preparation and purification of sols.
   - Define colloidal electrolyte.
   - List the optical and kinetic properties of sols.
   - Explain the electrical double layer.
   - Explain the electrokinetic effect as a consequence of electrical double layer.
   - Explain the difference between electrophoresis and sedimentation potential.
   - Explain the difference between electro-osmosis and streaming potential.
   - Explain the terms - associated colloids, gels and emulsions.
   - List the uses of colloids

2. The principles and applications of Phase Equilibria.
   - Define equilibrium.
   - Distinguish between true equilibrium, metastable equilibrium and unstable equilibrium.
   - Define the terms - system, phase, component, degrees of freedom.
   - State and derive the phase rule.
   - Apply the phase rule to one - component system.
   - Interpret liquid – vapour composition diagrams of two component systems using the phase rule.
   - Describe the distillation of partially mixable liquids.
   - Interpret phase diagrams in which the components take part in a reaction
   - Define the terms phase reaction and peritetic reaction.
- Describe the principles and applications of zonerefining and zone-levelling
- Interpret triangular - coordinate phase diagrams for three partially mixable liquids.
- Draw and explain the phase diagram of water, carbon dioxide and sulphur

**CLT 115: Organic Chemistry I**

- **Organic Chemistry I: 4 credits (60 hours); L, T, P, SPW**
  1. The application of spectrophotometric techniques in the identification of organic compounds
     - List the frequency range of UV radiation.
     - Explain the effect of the interaction of UV light with organic compounds.
     - Explain electronic transitions in terms of molecular orbital theory (p-p* and n-p*)
     - State wavelength in S.I. units and intensity of band as (E).
     - Explain that the wavelength of maximum absorption is called $\lambda_{\text{max}}$ and the intensity of absorption at $\lambda_{\text{max}}$ is $E_{\text{max}}$.
     - Give and be able to use the Beer-Lambert law relating absorbance to concentration.
     - Explain the use of UV spectrum in identification of unsaturated linkages, chromophores and aromatic systems.
     - Explain how the interaction of infra-red radiation with organic molecules gives rise to stretching, bending, vibration and wagging of the molecules.
     - Assign absorption frequencies to the following functional groups:
       - OH: -OR; -NH2; -X-C; HC=0; C=O; alkenes; alkynes and nitriles.
     - Explain how the “finger print’ region between 1450 - 650 L-1 is unique for any compound.
     - Explain how the substituent groups attached to a functional group affects the absorption frequency of the functional group.
     - Interpret the spectrum of a known compound.
     - Explain the theory of NMR.
     - Explain the term chemical shift with particular attention to chemical shift values for H1.
     - Understand that chemical shift is affected by the electronic environment of the nucleus - deshielding and shielding effects.
     - Identify chemical shifts for different types of protons.
     - Understand and be able to predict equivalence of hydrogen atoms in a molecule.
     - State the scales adopted for H1 nmr spectrum.
  2. The chemistry of monosubstituted aromatic compounds
     - State the general formulae for monosubstituted aromatic compounds.
Describe the physical and chemical properties of monosubstituted aromatic compounds.

State IUPAC names for monosubstituted aromatic compounds.

Know how to prepare monosubstituted aromatic compounds (by halogenation, nitration, sulphonation, alkylation, acylation) from non-substituted aromatic compounds.

Compare reactions of monosubstituted aromatic compounds with non-aromatic compounds.

List uses of monosubstituted aromatic compounds.

3. The principles of organic reaction mechanism applied to aromatic system.

Describe the following types of reactions, encountered in organic chemistry - addition, elimination, substitution and re-arrangement reactions.

Explain the following:

- Inductive, Mesomeric and Electromeric effects
- Identify ortho, para and meta positions on a monosubstituted aromatic compound.
- List examples of ortho-para directing and meta directing groups.
- Explain the term electrophiles and nucleophiles.

Describe the mechanism of electrophilic aromatic substitution and nucleophilic aromatic substitution. Electrophilic substitution with respect to the following:

- Halogenation of benzene;
- Nitration of benzene;
- Sulphonation of benzene
- Friedel craft reactions.

Draw diagrams of Energy against reaction co-ordinate for the above reactions and relate the shape of the Energy curves to the mechanism of the reaction.

List the differences between electrophilic aromatic substitution and nucleophilic aromatic substitution.

List other reactions of aromatic hydrocarbons like addition and oxidation reactions.

Describe SN1 and intermediate complex mechanism to aromatic nucleophilic substitution.

Know selected reactions of arenes: (oxidation of alkyl side chains, reduction of benzylic alcohols and ketones, chlorination of toluene)

Know selected reactions of aromatic substituents (reduction of the nitro group, oxidation of amino)
- Understand the principles of spectrophotometric techniques and their applications

**Contents:**

1. **The principles of analytical separations and their applications**
   - Describe the principles of extraction using partition coefficients and separate phases.
   - Discuss the effects of pH on extraction
   - Discuss the basic principles of chromatography and types of chromatography (adsorption; partition, ion-exchange; molecular exclusion/gel permeation; affinity chromatography).
   - Understand the fundamental differences between the types of chromatography in above.
   - Calculate the retention time of a solute and its relationship between partition coefficient.
   - Calculate the average volume percent of a compound from the peak areas.
   - Understand the differences between packed and open tubular columns and when they may be used.
   - Discuss the different types of detector used with GC,
   - Discuss the basic principles of HPLC
   - Discuss stationary phases: polar and non polar and understand the difference between normal and reverse phase chromatography
   - Discuss the different types of detector: spectrophotometric, refractive index, evaporative lights cattering, electrochemical.
   - Discuss the criteria used to optimise separation: capacity factor, resolution, peak shape, operating pressure
   - Describe different types of resins and their applications
   - Discuss the Donnan equilibrium and its role in ion-exclusion chromatography
   - Discuss the principles of ion chromatography for anion analysis
   - Discuss the principles of molecular exclusion/gel permeation chromatography
   - Discuss the principles of capillary electrophoresis
   - Draw a schematic diagram of the apparatus used for capillary electrophoresis
   - Discuss the basic principles of electroosmosis
   - Calculate the apparent mobility using the electrophoretic mobility and electrosmotic mobility
   - Calculate the number of theoretical plates
   - Discuss experimental factors affecting the condition of the capillary wall
   - Discuss the type of sample injection: hydrodynamic and electrokinetic.
   - Discuss the process of stacking and its effect on the resulting chromatogram
   - Discuss the type of detectors used with CE and their application
- Discuss the basic principles of Micellar electrokinetic chromatography

2. **The principles, applications of Flame photometry, Atomic absorption spectrometry, IR, UV-Visible spectroscopy**

- Explain the principle involved in qualitative identification of substances using flame tests. Describe the three types of emission spectrometry.
- Explain the error and interferences inherent in flame photometric analysis.
- Describe the evaluation methods used in flame photometry.
- Describe methods of preparing sample and stock solutions of standards in flame photometry and others (AAS)
- Describe the general applications of flame photometry and its limitations in relation to AAS. Explain the working principles of Atomic Absorption Spectrophotometer (AAS).
- Explain the errors and interferences in AAS.
- Explain the advantages and disadvantages of AAS over flame photometer.
- Discuss the use of graphite furnaces and inductively coupled plasmas as the method of atomisation
- Discuss the effect of temperature on AAS including the Boltzmann distribution
- Discuss the use of background correction and application of AAS
- Discuss the types of interference that may occur: spectral, chemical, ionisation
- Explain the fundamental principles of infra-red spectroscopy (highlighting liberation of diatomic molecules and polyatomic molecules).
- Classify molecular vibrations.
- Describe the characteristic absorption frequency (group frequency) of certain groups in the molecules e.g. -OH; -COOH; -NH2; CO.
- Discuss the use of Fourier Transform (Michelson Interferometers)
- Describe the preparation of substance for infra-red analysis using Nujol emulsion and KBr pellets etc.
- Explain the use of infrared (IR) in elucidation of structure of molecules.
- Explain the limitations of IR in analytical work.
- Solve problems on IR spectroscopy.
- Explain the fundamental principles of UV - Visible absorption spectrometry.
- Classify electron transitions with relationship to UV-Visible absorption.
- Explain the theory of light - absorption and transmission (Beer - Lambert’s law), A=εIC
- Describe the spectra of the main classes of organic compounds - alkenes, unsaturated compounds, nitrogen compounds, nitrocompounds, aromatic compounds and heterocyclics.
Illustrate diagrammatically the layout of UV – Visible spectrophotometer (power supply, light sources monochromators, detectors and measuring device).
Describe the optical layout of a double - beam UV – Visible spectrophotometer.
List the advantages of double beam over the single beam spectrophotometer.
Describe sample preparation for UV - Visible analysis with examples
Outline the main applications of colorimetric and spectrophotometric analysis:
  - spectrophotometric titration
  - determination of pKa
  - determination of pH of a given sample.
Explain the terms true fluorescence, phosphorescence, chemiluminescence and bioluminescence.
Differentiate between UV and fluorescence with respect to change in absorption maximum.
Explain how the intensity of fluorescence is proportional to the concentration of the substance in dilute solutions.
Explain the term “quantum yield” and “quenching”
Describe the various units of a spectrofluorimeter e.g. light source, photo-multiplier, recorder and its operation.
Describe the methods of preparation of a sample for analysis by spectrofluorimetry.
Explain the applications of fluorimetry and its limitation in analytical work.

**CLT 117: Bilingual training**

- **English : 1.5 credits (22 hours 30mn)); L, T, SPW**

1. **Vocabulary**
   - Technical and usual vocabulary of the specialty
2. **Grammar**
3. **Bilingual expression**
   - Understanding in interaction in Technical Discussions
   - Continuous oral communication: Show, explain, develop, summarize, account, comment;
   - Interactions oral communication

4. **Autonomous reading of "writings" of all levels**
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
   - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
5. **Write clear, detailed texts**
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

➢ **French : 1.5 credits (22 hours 30mn)); L, T, SPW**

1. **Vocabulaire**
   - Vocabulaire technique usuel

2. **Grammaire**
   - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   - Des fonctions grammaticales.

3. **Expression et communication**
   - Compréhension et interaction au cours d’une discussion technique ;
   - Communication orale courante ;
   - Communication orale interactive ;
   - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
   - Lecture rapide et compréhension de texte ;
   - Synthèse de texte
   - De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
   - Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
   - Expressions figées

❖ **CLT 121: Biochemistry for Chemists**

➢ **Biochemistry for Chemists: 4 Credits (60 hours); L, T, P, SPW**

**General objectives:**
- Understand carbohydrate, protein and lipid
- Understand the phenomenon of intermediary metabolism
- Understand the pathways of carbohydrate, protein and lipid metabolism
- Understand enzymes

Contents:

1. Carbohydrate, protein and lipid
   - Know the structures of the common amino acids
   - Understand that amino acids are linked by peptide bonds to give polypeptide chains
   - Know that proteins consist of one or more polypeptide chains
   - Know the common conventions and be able to use shortened nomenclature to give the sequence of a polypeptide chain
   - Know the common techniques used to purify proteins
   - Know an experimental technique for sequence determination based upon degradation
   - Understand that the 3D shape of a protein may be obtained from single crystal X-ray diffraction experiments
   - Know the local folding (conformations) motifs for polypeptide chains
   - Understand primary, secondary, tertiary and quaternary structure.
   - Understand that the shape and function of the protein is defined by its primary sequence
   - Be familiar with models of some simple proteins (e.g. albumin, ribonuclease, etc) and relate structure with function.
   - Carbohydrate: Definition, Mono-, di-, tri-, oligo-, poly-saccharides,
   - Nomenclature and types of bonds
   - Physicochemical Properties
   - Lipids: Definition
   - Nomenclature and types of bonds
   - Physicochemical Properties

2. The phenomenon of intermediary metabolism
   - Explain that metabolism in a living cell constitutes catabolic (breakdown) and anabolic (synthesis) processes which occur simultaneously.
   - Explain intermediary metabolism as the interchange ability of derivatives (metabolites) of carbohydrates, proteins and fats (lipids) via reactions mediated by appropriate enzymes and coupled by relevant coenzymes/cofactors.
   - Illustrate the central role of acetyl CoA in intermediary metabolism and describe how the energy for cellular metabolism is derived from the breakdown of acetyl COA
   - Explain how the energy from above is captured in the form of ATP (adenosine triphosphate) which is reversible
   - Describe ATP cycle and outline ATP as the universal energy currency in biological systems.
   - Explain how energy released from the degradation of some substrates may be utilized in the formation of other cellular components
- Explain that the sum total of breakdown of carbohydrates, fats and proteins is a chain reaction involving transfer of reactions which lead to the final products of cellular respiration (CO2 + H2O) and ATP.

3. **The Pathways of carbohydrate, protein and lipid metabolism**
   - List the enzymes and products of digestion of carbohydrate and explain the term ‘substrate level phosphorylation’.
   - Define glycolysis as the pathway of breakdown of phosphorylated sugars to provide energy and lactate.
   - Describe the glycolytic pathway and the conversion of pyruvate to acetyl COA.
   - List the key enzymes of glycolysis.
   - Identify the steps that consume or yield energy in the glycolytic pathway.
   - Deduce the net energy yield of this glycolytic pathway.
   - Distinguish between aerobic and anaerobic glycolysis.
   - Describe the alternative pathway of glucose oxidation (pentose phosphate pathway/hexose monophosphate shunt).
   - Define oxidation of fatty acids.
   - Describe the processes occurring in fatty acid oxidation (activation dehydrogenation, hydration, further dehydrogenation and Thiaclastic cleavage).
   - Describe the b-oxidation of fatty acids to acetyl COA.
   - Explain that the acetyl COA produced in fatty acid oxidation enters the TCA cycle for further degradation.
   - Describe the oxidation Via propionic acid of branched and odd-numbered fatty acids.
   - Explain that FADH2 and NADH + H+ produced in fatty acid oxidation are also oxidized through the electron transport system of the mitochondria eventually by molecular oxygen.
   - Compare the energy yield when one mole each of saturated and unsaturated fatty acids of equal chain length are completely oxidized.
   - Describe the formation and metabolism of ketone bodies (acetone, acetoacetate and p-hydroxy butyrate).
   - Describe the biosynthesis of fatty acids.
   - Describe the two pathways of fatty acid biosynthesis (cytoplasmic, mitochondrial).
   - Explain that the cytoplasmic pathway is the major pathway of fatty acid synthesis.
   - Describe the biosynthesis of triglycerides and phosphatides.
   - Describe the biosynthesis of sterols from cholesterol.
   - List the enzymes and products of protein digestion.
   - Explain how amino acids can be a source of cellular energy.
   - Explain how the carbon skeleton of amino acids are either converted into fatty acids and glucose or oxidized via the TCA cycle.
   - Explain the terms: ketogenic and glucogenic amino acids.
- List ketogenic and glucogenic amino acids.
- Explain transamination and oxidative deamination.
- Write chemical equations to illustrate the process in above.
- Describe the formation of urea.

4. **Enzymes**
   - Describe the distinctive features of enzymes
   - Explain enzymes specificity as the basis of classification.
   - Explain and determine enzymatic catalysis measurement by the rate of disappearance of substrate or formation of products.
   - Determine the effect of activators and inhibitors experimentally.
   - Define enzyme activity and specific enzyme activity in international units (IU) and SI unit. Explain methods of enzyme assay.
   - Explain how an enzyme reversibly combines first with its substrate to form an enzyme substrate complex.
   - Explain why the process of product formation from above is a slow process.
   - Explain the term Rapid Equilibrium
   - Explain steady state and Pre-steady state.
   - Explain and determine enzymecatalysed reactions measurement under initial rate (Vo) conditions
   - Derive the Michealis-Menten equation from the expression:
   - Explain the Kinetic constant, Km, Vmax, Kcat.
   - Explain the physiological significance of Km.
   - Describe the determination of Km and Vmax by using line weaver Buck plots.
   - Show that Km and Vmax can also be determined by Eddie-Hoffsted plots.
   - Define cofactors, activators, coenzymes and prosthetic groups.
   - Explain how the rate of enzymatic catalysis can be affected by the presence of cofactors and inhibitors.
   - Define reversible inhibitors.
   - Distinguish between competitive, uncompetitive and non-competitive inhibitors.
   - Describe transition state analogues as reversible inhibitors and relate this to chemical structure.

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**CLT 122: Biological and Chemical Instrumentation**

- **Biological and Chemical Instrumentation: 5 credits (75 hours); L, T, P, SPW**
  - General objectives:
    - Understand the principles and instrumentation of spectrophotometer and colorimetry.
    - Know the operation and care of flame photometer and Raman spectrometers.
    - Know the operation and care of Atomic absorption spectrophotometers (AAS).
    - Know the operation and care of the X-ray spectroscope.
- Know the operation and care of electrolytic conductivity bridge; coulometer titration; PH meter; autotitrator; polarograph.
- Know the operation and care of radioactive detectors and counters.
- Understand the operation and care of gas chromatographic equipment, fluorimeter, polarimeter and refractometer.
- Know the concept of hydrogen ion concentration.
- Know the various types of electrodes used in measuring ions like fluoride, nitrate, etc.
- Know use of microscopes.
- Know the principles of autoradiography.
- Know the use and maintenance of photomicrographic equipment.
- Know the use and maintenance of colony counter.
- Know the use and maintenance of autoclave, centrifuge and incubator.
- Understand the principle of automation and its significance in chemical analysis.

Contents:

1. The principles and instrumentation of spectrophotometer and colorimetry.
   - State the wave length within the electromagnetic spectrum.
   - Distinguish between wavelength of light within the visible region and invisible region.
   - Explain the similarities in the working principle of the colorimeter and spectrophotometer.
   - Identify the various parts of a colorimeter.
   - Explain the functions of the parts in 1.4 above.
   - State basic similarities and differences between a colorimeter and spectrophotometer.
   - Explain the limitations of colorimeter in microbiological studies.
   - Explain the term spectrophotometry.
   - List the various sources of light for spectrophotometric determination.
   - Describe diffraction grating
   - Explain the functions of diffraction grating in spectrophotometry.
   - Explain the term interference filter.
   - State the function of optical filter in spectrophotometry.
   - State the basic laws of spectrophotometry viz: Bonger Lambert’s law, Beer’s law.
   - Explain the working principles of the spectrophotometer.
   - List the functions of the parts in the optical system of a spectrophotometer.
   - List the different types of detections used in spectrophotometry.
   - List the functions of parts in the optical system of a spectrophotometer.
   - List the different types of detection used in spectrophotometry.

2. The operation and care of flame photometers and Raman spectrophotometers
   - Explain the principle of operation of the flame photometer.
   - Identify the various parts of a photometer.
- State the functions of the various parts of atomizer, e.g. carbon rod.
- State the similarities and differences between the spectrophotometer and flame photometer.
- List the errors inherent in practical flame photometry and how they can be corrected particularly as applied to biology.
- Explain how to correct the errors in above.
- Describe and carry out typical maintenance routines for the flame photometer.
- Identify parts of the Raman Spectrometers.
- Explain the functions of the parts in above.

3. **The operation and care of Atomic Absorption Spectrophotometers (AAS)**
   - Draw a schematic labeled diagram of the AAS.
   - Identify the parts of an AAS e.g. extension sources.
   - Describe the working principle of each of the component parts of the AAS (especially the hollow cathode lamp).
   - Outline the steps for operating the AAS.

4. **The operation and care of the X-ray spectroscope**
   - Identify the parts of the X-ray spectroscope.
   - Describe the parts listed in 4.1 above.
   - Draw a block diagram of an X-ray spectroscope.
   - Describe the operation and working principles of the units such as collimation, filters, analyzing crystals and detectors.
   - Draw non-dispersive X-ray absorption meter.
   - List the parts of an X-ray fluorescence spectrometer.
   - Identify and describe parts of an X-ray fluorescence spectrometer.

5. **The operation and care of analytical instruments**
   - List the component parts of:
     - Electrolytic conductivity bridge
     - Coulometric titration
     - Autotitration
     - PH meter
     - Polarograph.
   - Identify and describe the various parts of the instruments in above.
   - Explain the principle of operation of the instruments in above.

6. **The operation and care of radioactive detectors and counters**
   - List the various radioactive detectors and counters with photographic envision, ionization chambers and proportional counters, scintillation counters, semi-conductor detectors, Geiger-Muller counter.
   - Explain the operation of each detector and counter in 6.1 above.

7. **The operation and care of gas chromatographic equipment fluorimeter, polarimeter and refractometer**
   - Explain gas chromatography
   - Identify the parts of:
     - Gas chromatograph
     - Fluorimeter
- Polarimeter
- Refractometer
  - Explain the working principles of each instrument in above

8. **concept of hydrogen in concentration**
  - Explain the term pH
  - Explain why the pH scale ranges from 0 to 14.
  - State Bronsted-Lowry theory of acid and base.
  - Calculate the pH of an acid and a base applying the theory in above.
  - Explain the functions of buffer with example.
  - Enumerate the main problems involved in pH measurement.
  - Explain how the problems in above are overcome.
  - Describe the potentiometric method of determination of pH.

9. **Types of electrodes used in measuring ions like fluoride, nitrate, etc.**
  - Identify ion – selective electrodes
  - State the uses of ion - selective electrodes
  - Explain the basic principles of operations of an ion-selective electrode.
  - Explain the relationship between activity and concentration of an ion.
  - List the various types of gas measuring electrodes.
  - Identify an oxygen electrode.
  - Identify the various uses of an oxygen electrode.
  - List and describe electrodes for pH measurement
  - Describe the routine maintenance of electrodes

10. **The use of microscopes**
  - Define microscopy
  - List various techniques of microscopy e.g. bright field, dark field etc.
  - Explain the techniques in above.
  - Identify various types of microscopes.
  - Identify the parts of the microscopes in above.
  - Explain the principles of operation of the microscopes in above (elementary treatment only).

11. **The principle of autoradiography**
  - Explain autoradiography
  - Identify the components used in autoradiography
  - Describe the applications of autoradiography
  - Demonstrate the techniques of autoradiography.

12. **The use and maintenance of photomicrographic equipment**
  - List the applications of photomicrography equipment.
  - Explain the working principles of photomicrography equipment.
  - Describe the working parts of photomicrography equipment.

13. **The use and maintenance of colony counters**
  - Identify types of bacterial colony counters.
  - Identify the parts of the counter in 13.1 above.
  - Explain the function of each part in 13.2 above.
  - Describe the principle of operation of the colony counter
14. **The use and maintenance of autoclave, centrifuge and incubator**
   - State the functions of:
     - Autoclave
     - Centrifuge
     - Incubator.
   - Identify the parts of the instruments above.
   - Explain the functions of the parts above.

15. **The principle of automation and its significance in chemical analysis**
   - Know the importance of automation.
   - Explain the following terms as they relate to automation: (i) Precision (ii) Reliability (iii) Speed (iv) Accuracy
   - Know the tasks involved in automation e.g. dispensing of samples and reagent in precise, predetermined volume
     - Mixing of samples with reagent
     - Incubation
     - Recording of absorbance
     - Calculation and determine results
     - Printing the results.
   - Differentiate between semi automated and fully automated analysers e.g. batch analyzer, semi automated, random access.
   - Know the terminologies used in automation.

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**CLT 123: Polyfunctional Compounds**

- **Polyfunctional Compounds: 5 credits (75 hours); L, T, P, PW**

**General objectives:**
- Understand the chemistry of dicarbonyl compounds.
- Understand the chemistry of saturated dicarboxylic acids and their derivatives
- Understand the chemistry of polyhydric alcohols.
- Understand the chemistry of some physiological important amino acids.

**Content.**

1. **Chemistry of dicarbonyl compounds.**
   - Draw structures and derive IUPAC and common names of 1, 2 – dicarbonyl compounds.
   - List properties of ethanedial and diphenyl diketone
   - Describe properties and reactions of 1,2 -dicarbonyl compounds
   - List examples (structures, IUPAC names and uses) of 1,3 – dicarbonyl compounds.
   - List and describe properties of 2,4 - pentanedione as a representative of 1,3 - dicarbonyl compounds.
   - Draw tautomers of 2,4 - pentanedione.
   - List examples (structures, IUPAC names and uses) of 1,4 – dicarbonyl compounds.

2. **Chemistry of saturated dicarboxylic acids and their derivatives**
- Write the general formula for saturated dialkanoic acids as CnH2n (COOH)2.
- Write the general formula of dialkanoic acids.
- Describe the general methods of preparation of dialkanoic acids.
- Describe properties and reactions of dialkanoic acids.
- List uses of dialkanoic acids.
- Write the structure of malonic ester
- Write the two tautomeric forms of malonic ester.
- Describe methods of preparation of malonic ester.
- Describe the properties and reactions of malonic ester.
- Explain the significance of the active methylene group in the reactions of malonic ester.
- Describe the application of malonic ester in the synthesis of other acids.
- Draw structure of aceto–acetic ester.
- Describe methods of preparation of acetic ester.
- Describe the properties and reactions of acetoacetic ester.
- Explain the significance of the active methylene in the reactivity of acetoacetic ester.
- Describe the applications of acetoacetic ester in the synthesis of other organic compounds (e.g. methyl ketones and alkanolic acids)

3. Chemistry of polyhydric alcohols.
- Define polyhydric alkanol.
- Describe general method of preparation of polyhydric alkanols.
- Describe the properties and reactions of polyhydric alkanols.
- List uses of polyhydric alkanols.
- Describe a method of determining the number of OH groups in a polyhydric alkanol.

4. Chemistry of some physiological important amino acids.
- Define an amino acid.
- Write the general formula of amino acid.
- List examples of amino acids.
- List and explain essential amino acids.
- Explain optical isomerism in amino acids.
- Differentiate between basic and acidic amino acids.
- List examples of both basic and acidic amino acids.
- Explain isoelectric point of an amino acid.
- Explain the biological importance of amino acids.
- Describe the general method of synthesis of á - amino acid.
- Describe the properties and reactions of á - amino acid as an acid.
CLT 124: Chemical Kinetics

Chemical Kinetics: 5 credits (75 hours): L, T, P, SPW

General objectives:
- Understand the principles and applications of chemical kinetics
- Understand the dynamics of molecular reactions

Content:

1. **Principles and applications of chemical kinetics**
   - Define true rate in terms of the advancement of a reaction.
   - Describe how rates are measured experimentally
   - Derive the first and second order rate laws.
   - Define the order of a reaction.
   - Describe how the concentrations of reactants and products are monitored in a chemical reaction.
   - Define pseudo-first order rate law.
   - Define the half-life of a reaction.
   - Relate the half-life of a reaction to reaction order.
   - Explain the terms molecularity of reaction, mechanism of reaction, simple reaction.
   - Distinguish between order and molecularity of reaction.
   - Derive the rate laws for reactions involving equilibria.
   - Relate equilibrium constant to the rate coefficient of simple reactions
   - Derive the rate law for parallel reactions.
   - Derive the rate law for consecutive reactions.
   - Explain the steady – state approximation.
   - Define the rate - determining step of a reaction.
   - Derive the rate laws for reactions involving a preequilibrium.
   - Define the terms catalysts, acid catalyst and base catalyst and explain their mode of operation

2. **The dynamics of molecular reactions**
   - State the collision theory of bimolecular gas-phase reactions.
   - Calculate the second - order rate coefficient from collision theory.
   - Define P-factor and the reactive cross-section.
   - Distinguish between diffusion - controlled and activation – controlled reactions in solution.
   - Relate the second order rate coefficient to the diffusion coefficient and viscosity
   - Explain the terms - activated complex, reaction co-ordinate and transition state.
   - Describe the activated complex theory of reaction rates.
   - Define Gibb’s function of activation, entropy of activation and enthalpy of activation
   - Explain the basis of the kinetic salt effect.
   - Derive the magnitude of kinetic salt effect
   - Explain how molecular beams are used to study reactive collisions.
Sketch the potential energy surface of a simple reaction.

Distinguish between attractive and repulsive surfaces and explain how they control the energy requirements of a reaction.

**CLT 125: Industrial Chemistry**

- **Industrial Chemistry: 4 credits (60 hours); L, T, P, SPW**

**General objectives:**
- Know the scope of the chemical industry
- Understand the general principles involved in quality control in chemical industries
- Understand the chemical principles involved in the manufacture of soap and detergent
- Understand the chemical principles and process involved in the manufacture of fertilizers
- Know the principles and processes of glass manufacture.
- Understand the processes involved in the manufacture of cement
- Understand the processes involved in the manufacture of leather
- Understand the mechanism of polymerisation reactions and properties of polymers
- Understand the chemistry of paints
- Know the basic science of pulp and paper making

**Content:**

1. **The scope of the chemical industry**
   - Outline the scope of chemical technology and chemical process industry.
   - List the chemical process industries in the country.
   - List major raw materials and their sources for the use of the industries above.
   - Classify the raw materials above into organic and inorganic materials.
   - Define the word “chemical” as used in industry and classify them into “heavy and Fine” chemicals.

2. **General principles involved in quality control in chemical industries**
   - Define quality control and its significance in Industrial Processes.
   - Explain the following terms used in quality control process:
     - quality assurance
     - Continuous process and batch process
     - specification
     - automation
   - List steps involved in quality control procedure (Raw materials, Intermediary, Finished Product).
   - Define sampling and describe sampling procedure in quality process.
   - Explain the role of regulatory bodies in quality control

3. **Chemical principles involved in the manufacture of soap and detergent**
Differentiate between soap and detergent.
Differentiate between soft (bathing) soap and hard (laundry) soap.
List the basic raw materials used industrially in soap making.
Describe the major methods used industrially in soap making.
Describe the methods of soap purification.
List the basic raw materials and methods used in the manufacture of detergent.

4. Chemical principles and process involved in the manufacture of fertilizers
   - List various types of fertilizers viz: nitrogen, phosphate, potassium etc.
   - Explain the principles involved in the production of a named fertilizer.
   - List the raw materials for the production of a named fertilizer.
   - Explain the various steps involved in the production of a named fertilizer, and write relevant equations for the reactions in each step.
   - Explain the main difference between chemical fertilizer and organic fertilizer.

5. The principles and processes of glass manufacture.
   - Define glass.
   - The physical properties of glass e.g. light permeability, hardness, brittleness etc raw materials to the glass industry: (a) sand (b) oxides of potassium, sodium, calcium, lead, boric acid and phosphate. (c) Pigments, agents, discoloring agents, clearing agents. (d) BaO (BaCO3), ZnO for thermometer glass, Al2O3 in the form of Kaolin.
   - Classify glass into the following: (a) soft glass (b) hard glass (i) monax (ii) pyrex (iii) firmssil (iv) phoenix
   - Describe the different methods used in glass manufacture and classify the glasses based on each method.
   - Demonstrate the only possible technique to bring glass into solution (dissolution in HF).

6. The processes involved in the manufacture of cement
   - Explain the term cement, and “Portland cement”.
   - Describe the steps involved in cement manufacture.
   - Explain firing and the accompanying reactions:
     - Decomposition of lime stone
     - Dehydration of clay
     - Combination of CaO with Al2O3 to form CaOAl2O3 and with SiO2 to form 2CaO.SiO2.CaO.Al2O3.
   - List the composition of a typical cement sample.
   - Explain the effects of the following, on the properties of the cement sample above
     - the fitness of ground raw material
     - the accurate determination of the ratio of the components
     - the temperature and firing time
     - the rate of cooling

7. The processes involved in the manufacture of leather
   - Define Leather in term of stabilized collagen.
- Explain the constitution of animal skin/hide.
- Describe the methods of preservation of hides and skins.
- State the chemical reactions involved in the following process (a) soaking (b) unharing (c) pulping (d) neutralization (e) tanning (f) fertiliquoring (g) dyeing
- Describe the methods of quality control in the leather industry.
- Describe various physical and chemical tests carried out in leather to ascertain its quality.
- State the grading patterns of leather and hides/skin.
- Describe the various uses of leather in making belt, shoes, bags etc.

8. **The mechanism of polymerisation reactions and properties of polymers**
   - Define polymerization, monomers and initiators.
   - Explain the differences between addition and condensation polymerization.
   - Describe the mechanism for free radical addition polymerization viz: initiation, propagation and termination reactions.
   - Describe polymer structure and isomerism
   - List factors affecting crystallization of polymer.
   - List the properties of crystalline and amorphous polymers.
   - Explain glass transition temperature (Tg) and melting temperature of amorphous and crystalline polymers.
   - List factors affecting melting temperature and glass transition temperatures of crystalline polymers.

9. **Chemistry of paints**
   - Define paints.
   - Classify paints
   - List the raw materials for the manufacture of paints:
   - Explain the ratio of mixing the raw materials in paint manufacture.
   - State the temperature conditions for the manufacture of paints.
   - Explain the colouring processes involved in paint manufacture
   - Explain the uses of paints.
   - Explain the methods of storage of paints

10. **Know the basic science of pulp and paper making**
    - Identify materials for pulping.
    - Compare hardwood and soft wood.
    - Describe the pulping and paper characteristics of the types of woods above.
    - Describe the reactions of different constituents of wood with chemical reagents - acids, strong and weak bases.
    - Explain the general principles of pulping.
    - Classify the various pulping processes: mechanical, semi chemical and chemical.
    - Classify various chemical pulping processes
- Describe the following new trends and developments in chemical pulping processes - multistage pulping, organosolent pulping, introduction of anthra quinone (AQ).
- Describe the various pulp purification; bleaching and finishing processes and state the aims of the various operations.
- Explain chemical recovery processes in pulping and bleaching operations.
- Describe various methods used in stock preparation.
- Describe the paper manufacturing unit
- Describe quality control method in pulp and paper industry.

**CLT 126: Chemical Analytical Techniques**

- **Chemical Analytical Techniques: 4 credits (60 hours); L, T, P, SPW**

**General objectives:**
- Understand the principle, operation and application of NMR Spectroscopy
- Understand the principles, operations and applications of mass spectroscopy
- Understand the principles, operations and applications of X-ray diffraction
- Understand the principles, operations and applications of surface analysis techniques
- Understand the basic principles and applications of Biosensors

**Content:**

1. **Principle, operation and application of NMR Spectroscopy**
   - Explain the fundamental principles of the NMR technique.
   - Draw a schematic diagram of the NMR Spectrometer.
   - Describe the basic principles of NMR spectrometer.
   - List the important nuclei used for NMR (spin-1/2 nuclei)
   - Explain the term: chemical shift.
   - Understand how to calculate intensity using the integral of the signal curve.
   - Explain the terms: spin-spin coupling, spin-decoupling.
   - Discuss the use of fourier transform in NMR
   - Describe the chemical shifts from common organic compounds for 1H nuclei from common organic compounds for 13C nuclei
   - Discuss the type of information that can be gained from spin-spin coupling constants (J numbers)
   - Explain the applications of NMR spectroscopy.

2. **Principles, operations and applications of mass spectroscopy**
   - Draw a schematic diagram of a Mass Spectrometer.
   - Describe the working principle of a mass spectrometer.
   - Understand the differences between the three concepts of mass used in MS: average, nominal and exact molecular mass.
   - Discuss the three types of data output that may be obtained using a MS: total-ion chromatogram, mass chromatogram, mass spectrum.
   - Describe other applications of mass spectroscopy.
- Describe the use of mass spectra in qualitative analysis of a mixture.
- Discuss the use of coupled MS techniques such as ICP-MS, GC-MS and LC-MS

3. **Principles, operations and applications of X-ray technique**
   - Describe the X-ray diffraction method.
   - Discuss the two classes of symmetry operations used to describe the internal arrangement of atoms or molecules in crystals: proper and improper
   - Discuss the seven crystal systems and their unit cells
   - Discuss the use of Bragg reflections and structure factors for structural analysis
   - Discuss the analytical applications of powder diffraction

4. **Principles, operations and applications of Surface Analysis techniques**
   - Discuss the characteristic surface features that can help determine the properties of a material: topology and morphology, elemental composition, chemical bonding of elements, structure (geometric and electronic)
   - Discuss the three main types of photon probe techniques: scattering, absorption and emission. Give examples for each at the different spectral ranges
   - Understand the principles of photoelectron spectroscopy including UPS and XPS
   - Draw a schematic of an XPS instrument
   - Discuss the major differences between UPS and XPS
   - Discuss the principles and applications of Laser Micro Mass Spectrometry (LAMMS)
   - Identify the main differences between photon probe and electron probe techniques
   - Discuss the fundamental principles of electron penetration of material and elastic and inelastic interaction with matter
   - Draw a simple diagram of the configuration of a scanning electron microprobe for secondary and back-scattered electron imaging and X-ray analysis
   - Discuss the use of secondary and back-scattered electron imaging and the differences between these two methods
   - Discuss the principles and applications of transmission electron microscopy
   - Understand the principles of scanning tunnelling microscopy (STM)
   - Discuss the type of information that can be gained from a STM image: topography, electronic structure
   - Discuss the different operational modes of STM identifying the differences in the information gained
   - Discuss the principles of Atomic Force Microscopy
- Discuss the different operational modes of AFM (constant force and constant height)
- Discuss the different information that can be obtained using the AFM: topography, deflection, phase lag, interactive forces, magnetic properties, conducting properties
- Understand the principles of phase lag imaging using tapping mode AFM
- Discuss the applications of AFM

5. **The basic principles and applications of Biosensors**
   - Understand what separates a biosensor from any other chemical sensor
   - Discuss the use of a biorecognition agent to give selectivity for the analyte
   - Discuss the immobilisation of the biorecognition agent: physical adsorption, physical retention in polymer matrices, surface modification. Highlight issues with applying the immobilisation layer to the sensor surface
   - Discuss the principles of enzyme electrodes
   - Using the glucose oxidase enzyme as an example discuss the reaction pathways for amperometric measurement via a redox mediator
   - Discuss the use of NAD-linked enzyme electrodes
   - Discuss the basic principles of optical biosensors; intrinsic and extrinsic
   - Understand the principles of labelled assays for optical detection
   - Discuss techniques that can be used to amplify optical changes in unlabelled assays: interference techniques, grating couplers, surface plasmon resonance (SPR)

[CLT127: Computer Science and Entrepreneurship]

- **Computer Science** : 2 credits (30 hours); L, T, P, SPW
  
  Computer structure, introduction to some basic computer software’s (World, Office, Excel, SPSS, Epi Info, Matlab), using computer software for data analysis, information and data transfer, storage and security, using internet and social networks.

- **Entrepreneurship**: 1 credits (15 hours); L, T, SPW
  
  1. Concept of an entrepreneur
  2. Motivations in the creation of a business
  3. Search for ideas and evaluation
  4. Search for funding
  5. Choice of legal status
  6. Ethical aspects of business
CLT 231: Computer Applications in Chemistry

- Computer Applications in Chemistry: 4 credits (60 hours); L, T, P, SPW

General objectives:
- Be able to use chemistry drawing packages such as "Chem Draw" or "ISIS Draw".
- Be able to use molecular modelling packages such as "Chem3D" or similar
- Be able to use specialist graph plotting and analysis software packages such as "Origin", "Sigmaplot", "Igor" or similar.

Content:
1. Use chemistry drawing packages such as Chem Draw or ISIS Draw

Students should be able to:
- Launch the drawing package, create new documents, save documents and open existing documents.
- Use menus to set or select drawing preferences such as bond length, bond angles, line width, page set up, etc.
- Select drawing tools from the menus to draw new bonds, add new bonds, and construct drawings of very simple organic molecules
- Print the drawing.
- Draw double and triple bonds
- Draw rings by using the appropriate ring tool or template from the menus
- Draw fused rings by using the same ring tools as above
- Add atom labels to drawings/repeat atom labels and delete atom labels
- Add captions to drawings
- Format text
- Use orbital tools to select and draw orbitals
- Use chemical symbol tools to select and draw lone pairs, radicals, and charges.
- Select and use the appropriate tools to draw: reaction arrows, arcs, and other shapes.
- Use the eraser tool to delete individual bonds, charges, arrows, etc.
- Select objects by using the selection tool
- Select objects by using the mouse buttons
- Add to the selection and delete the selection
- Select and move objects
- Select and duplicate objects
- Select and rotate objects
- Select and resize objects
- Select and group objects
- Select and align objects
- Use the crosshair
- Cut and paste within the package
- Cut and paste from the package into other packages such as word processing packages
2. **Use molecular modelling packages such as "Chem3D" or similar**
   - Explain the reasons for modelling molecules and reaction intermediates on computers
   - Understand the general concepts involved in computer molecular modelling
   - Understand the mathematical principles underlying modeling procedures (Newtonian Mechanics [e.g. MM2], semi empirical [e.g. MOPAC] and quantum mechanical methods.
   - Discuss the relative merits of the different methods of modelling given above.
   - Launch a modeling programme and create an empty model page or window
   - Select a pre-existing model from a template menu
   - Use rotation tools to rotate and examine the molecule
   - Save the new rotation and print the new view
   - Open an existing file
   - Import a model created by the same or a different modelling programme
   - Build a new molecule by using the tools available in menus
   - Build a new model by using a drawing programme and importing the resulting file into the modeling programme
   - Change an atom to another element
   - Change bonds
   - Add fragments
   - Delete atoms and bonds
   - Set charges
   - Change stereochemistry
   - Select atoms, bonds or groups of atoms and bonds by using the selection tools from menus
   - Select atoms, bonds and features by using the mouse buttons
   - Move atoms or models
   - Rotate fragments of models
   - Change orientations of fragments
   - Resize models
   - Change the appearance of a model (wire frame, sticks, ball and stick, spacefilling, dot surfaces, ribbons, etc)
   - Change colours
   - Change atom and bond sizes
   - Change element symbols
   - Display stereo views
   - Display model data (atoms and serial numbers, bond angles, dihedral angles, distance between two atoms, etc)
   - Dock models
   - Compare models by overlaying
- Export using different file formats
- Export by using the clipboard
- Use the modeling programme to compute the stability of different conformations of the same simple molecule
- Use the modeling programme to minimise the energy of molecules
- Use the modeling programme to find the lowest energy conformation of simple and more complex molecules e.g. aspirin
- Use the semi-empirical functions [MOPAC] of the programme to determine $\Delta H_f$.

3. **Use specialist graph plotting and analysis software packages such as "Origin" or "Sigmaplot" or "Igor" or similar**
   - Explain the relationship between a specialist graph plotting and analysis programme and a spreadsheet programme such as Excel.
   - Launch the specialist graph plotting and analysis programme
   - Input data directly into the programme's worksheet
   - Import data into the worksheet from a spreadsheet package such as Excel
   - Use menu commands to plot a graph of the data contained in the worksheet
   - Use menu and or mouse commands to edit the resulting graph (change: axes, labels, symbols, text, resizing, etc)
   - Save graphs and data files
   - Save files in different formats (e.g. "standard formats such as TIF files"
   - Export data files and graphs into other programmes such as spreadsheets and word processors
   - Use menu commands to analyse data in the worksheet
   - Obtain basic statistical from the data in the worksheet (statistics on rows and columns, t-tests, ANOVA, etc)
   - Use the curve fitting functions e.g. exponential, linear regression, sigmoidal, hyperbolic, etc.
   - Use the hyperbolic functions to analyse Michaelis Menten kinetics and obtain the kinetic parameters for suitable enzyme catalysed reactions

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**CLT 232: Petroleum and Petrochemicals**

- **Petroleum and Petrochemicals: 5 credits (75 hours); L, T, P, SPW**

**General Objectives:**
- Know the primary raw materials for petrochemicals, treatment processes and properties
- Know the hydrocarbon intermediates (secondary raw materials) for the production of petrochemicals
- Understand crude oil processing and the production of hydrocarbons
- Know the extraction and uses of non-hydrocarbon intermediates
- Describe petrochemicals based on methane
- Describe petrochemicals based on ethane and higher paraffins
- Describe petrochemicals based on ethylene
- Describe petrochemicals based on propylene
- Describe petrochemicals based on C4 Olefins and Diolefins
- Describe petrochemicals based on benzene, toluene and xylene
- Be familiar with synthetic petroleum based polymers

Content:

1. **The primary raw materials for petrochemicals, treatment processes and properties**
   Students should be able to
   - Discuss the origin of petroleum raw materials
   - Know the composition of Natural Gas
   - Describe treatment processes for Natural Gas
   - Discuss Natural Gas Liquids (NGL)
   - Describe properties of Natural Gas
   - Know the composition of crude oils
   - Describe the properties of crude oils
   - Understand crude oil classification

2. **The hydrocarbon intermediates for the production of petrochemicals**
   - Know the paraffinic hydrocarbons (methane, ethane, propane, and butanes) and their role as secondary raw materials
   - Know the olefinic hydrocarbons (ethylene, propylene, butylenes) and their role as secondary raw materials
   - Discuss the dienes: butadiene and isoprene
   - Describe the extraction of aromatics and discuss their role as secondary raw materials
   - Discuss Liquid Petroleum Fractions and Residues: Naphtha, Kerosine, Gas Oil, Residual Fuel oil

3. **Crude oil processing and the production of hydrocarbons**
   - Physical separation processes: atmospheric and vacuum distillation, absorption, adsorption, and solvent extraction
   - Conversion processes: thermal processes and catalytic conversion processes alklyation processes, isomeriasation processes etc
   - Production of olefins: steam cracking
   - Production of diolefins

4. **Extraction and uses of non-hydrocarbon intermediates**
   - Know the extraction and uses of hydrogen
   - Know the extraction and uses of sulphur
   - Know the extraction and uses of carbon black
   - Discuss the production and uses of synthesis gas

5. **Describe petrochemicals based on methane**
   - Discuss the direct conversion of methane into: carbon disulphide, hydrogen cyanide, chloromethanes.
   - Describe the production of methanol from synthesis gas
   - Discuss the uses of methanol as a fuel
   - Describe the uses of methanol as a feedstock
- Discuss the production of hydrocarbons from methanol
- Know the MTG process (methanol to Gasoline)
- Know the production of ethylene glycol (anti-freeze) from synthesis gas.

6. **Describe petrochemicals based on ethane and higher paraffins**
   - Describe the isolation and uses of ethane
   - Describe the isolation and uses of propane
   - Discuss reactions of propane and uses of the resulting products
   - Describe the isolation and uses of butanes
   - Discuss reactions of butanes
   - Discuss petrochemicals from high molecular weight n-paraffins (oxidation, chlorination, sulphonation, etc)

7. **Describe petrochemicals based on ethylene**
   - Describe the production and isolation of ethylene
   - Know the importance of ethylene in the petrochemical industry
   - Discuss the production of ethylene oxide and its uses as a feedstock in the production of derivatives
   - Know the carbonylation, chlorination, hydration, and oligomerisation of ethylene
   - Discuss alkylation using ethylene

8. **Describe petrochemicals based on propylene**
   - Describe the production and isolation of propylene
   - Discuss the oxidation of propylene
   - Know the oxyacylation of propylene
   - Discuss the hydration of propylene and the uses of isopropanol
   - Describe the hydroformylation of propene

9. **Describe petrochemicals based on C4 Olefins and Diolefins**
   - Describe the isolation of n-butene, isobutene and butadienes
   - Discuss the oxidation of n-butenes and uses of the resulting petrochemicals
   - Discuss the production and uses of petrochemicals from isobutylene: oxidation, epoxidation, addition of alcohols, hydration, carbonylation, and dimerisation
   - Discuss the production of petrochemicals from butadiene: adiponitrile, hexamethylene diamine, adipic acid, and butanediol

10. **Describe petrochemicals based on benzene, toluene and xylenes**
    - Describe the isolation of benzene, toluene and xylene
    - Describe the reactions of benzene (alkylation, chlorination, nitration, oxidation, and hydrogenation) and uses of the resulting products
    - Describe the reactions of toluene (dealkylation, disproportionation, oxidation and carbonylation)
    - Know the production of terephthalic acid, Phthalic anhydride and isophthalic acid from xylenes.

11. **Synthetic petroleum based polymers**
    - Discuss the importance of synthetic petroleum based polymers
- Discuss thermoplastics (polyethylene, polypropylene, PVC, polystyrene, Nylon resins and thermoplastic polyesters
- Discuss thermosetting plastics: polyurethanes, epoxy resins, unsaturated polyesters
- Discuss synthetic rubbers: butadiene polymers and copolymers, nitrile rubbers, polisoprene and butyl rubber
- Discuss synthetic fibres: polyester fibres, polyamides, acrylic and modacrylic fibres, carbon fibres and polypropylene fibres.

**CLT 233: Inorganic Chemistry II**

- **Inorganic Chemistry II: 5 Credits (75 hours); L, T, P, SPW**

**General objectives:**
- Understand the chemistry and uses of non-aqueous system
- Understand the chemistry and application of silicates
- Understand the production of silicones by the hydrolysis of alkyl substituted chlorosilanes
- Understand supramolecular chemistry and binding of metal ions by macrocyclic molecules
- Understand the chemistry of the inert (noble) gases

**Content:**

1. **Chemistry and uses of non-aqueous system**
   - Describe aqueous and non-aqueous solvents.
   - Classify solvents as aqueous and nonaqueous.
   - State the Arrhenius definitions of acids and bases.
   - Describe the autoionization of nonaqueous acids and bases.
   - Describe liquid ammonia as a nonaqueous solvents and the behaviour of metals in liquid ammonia.
   - List the chemical properties and uses of metalammonia solutions.
   - Compare the acidic strength of the hydrogen halides.
   - Compare the physical properties of the hydrogen halides along the following parameters - melting points, boiling points, specific conductivity, dielectric constant.
   - Explain the behaviour of anhydrous tetraoxosulphate (vi) acid.
   - Describe the preparation of glacial ethanoic acid and explain its use as a nonaqueous solvent.
   - Describe the structure and uses of dinitrogen tetraoxide.
   - Compare the electrical conductivity of a range of univalent electrolytes in liquid sulphur (iv) oxide.
   - State the boiling point, melting point and the dielectric constant of sulphur(iv) oxide at 0 °C.

2. **Chemistry and application of silicates**
   - Define a silicate and describe simple methods of preparation
   - Classify silicates and explain bonding patterns involve
• Draw and describe the structure of orthosilicates giving specific examples
• Describe the structure and composition of a pyrosilicate and specific examples
• Draw the structure of cyclic silicate and describe its composition.
• Explain the structure of both chain and sheet silicates and draw the structure of each of them.
• Differentiate between the various forms of silicates.
• List the properties and uses of silicates.

3. The production of silicones by the hydrolysis of alkyl substituted chlorosilanes
• List the starting materials for the manufacture of silicones.
• Describe the synthesis of silanes and their derivatives.
• Describe the hydrolysis of trialkyl monochlorosilane to yield hexaalkyl siloxane.
• Describe the hydrolysis of dialkyl dichlorosilane to yield straight chain polymers.
• Describe the hydrolysis of alkyl trichlorosilane to yield a very complex cross linked polymer.
• Describe what happens when mixtures of trialkyl monochlorosilane and dialkyl dichlorosilane are hydrolysed a list the products obtained
• Describe what happens when silicones are heated in the presence of air to 350oC - 400oC.
• Describe what happens when silicones are heated to higher temperature in the absence of air.
• List the properties and uses of silicones.

4. Supramolecular chemistry and binding of metal ions by macrocyclic molecules
• Describe supramolecular chemistry in general terms and define host-guest systems
• Describe some selected examples from biochemistry
• Discuss the non-covalent interactions at the disposal of supramolecular systems
• Discuss design principles including chelate and macrocyclic effects
• Describe methods used to characterize supramolecular systems
• Discuss structural, kinetic and thermodynamic aspects of supramolecular systems
• Justify the investigation of cation binding macrocycles
• Discuss the chemical synthesis of suitable macrocycles
• Discuss co-ordination and template effects
• Describe Crown ethers
• Discuss the Host-Guest chemistry of Crown Ethers
• Describe Cryptands, Spherands, Calixarenes, Sepulchrates, Siderophores, and compare their supramolecular chemistries
Discuss present and future applications: phase transfer reagents, separating systems, electrochemical sensors, switches and molecular machinery, supramolecular catalysis, drugs etc.

5. Chemistry of the inert (noble) gases

- List the inert gases.
- Write the electron configuration of the inert gases.
- Explain the significance of the electron configuration of inert gases.
- List the general properties of inert gases.
- Relate the general properties to the electron configuration of the inert gases.
- Describe the following reactions: reaction of helium under excited condition, formation of clathrate compounds by the inert gases, formation of co-ordination compounds by the inert gases
- List the uses of inert gases.

CLT 234: Chemical Thermodynamics

- Chemical Thermodynamics: 4 credits (60 hours); L, T, P, SPW

General Objectives:
- Understand the basic concepts of thermodynamics
- Understand the heat changes in reactions
- Understand the concepts and applications of the second law of thermodynamics

Content:

1. The basic concepts of thermodynamics
   - Explain the scope of thermodynamics.
   - Define universe, system and surroundings.
   - Classify thermodynamic systems as open, closed and isolated.
   - Define internal energy, heat and work.
   - State the first law of thermodynamics.
   - Calculate the work done when gas expands against an external pressure.
   - Explain thermodynamic reversibility.
   - Define isothermal process and adiabatic process.
   - Calculate the work done during the isothermal expansion of an ideal gas.
   - Calculate the change in internal energy during the isothermal reversible expansion of an ideal gas.
   - Define heat capacity and enthalpy of reaction.
   - Relate changes of enthalpy in a system to the heat transferred at constant pressure.
   - Define extensive and intensive properties.
   - Define state function and path dependent function.
   - Explain the terms: exact differentials and in-exact differentials.
- Relate changes of internal energy to changes in volume and temperature.
- Deduce expressions for the dependence of the internal energy on the temperature at constant pressure using the properties of partial derivatives.
- Deduce expressions for the dependence of the enthalpy on the temperature at constant volume using the properties of partial derivatives.
- Define isobaric expansivity and isothermal compressibility
- Derive the relation between heat capacities at constant volume and constant pressure.
- Calculate the work done by an ideal gas during adiabatic change.
- Calculate the final volume, pressure and temperature of an ideal gas after a reversible, adiabatic change of volume.

2. **The heat changes in reactions**
   - Define the terms endothermic reaction, exothermic reaction and reaction enthalpy.
   - Define standard state of reaction.
   - State Hess's law of constant heat summation.
   - Use Hess's law to calculate the various heats of reaction.
   - Relate reaction enthalpy to change in internal energy.
   - Define enthalpy of sublimation, enthalpy of combustion, enthalpy of solution and enthalpy of neutralization.
   - Calculate the various enthalpies above.
   - Define enthalpy of hydrogenation, bond enthalpy, enthalpy of atomization and enthalpy of phase transition.
   - Construct the Born-Haber cycle and use it to determine enthalpies from other data.

3. **The concepts and applications of the second law of thermodynamics**
   - State the criteria for the direction of spontaneous change.
   - Define thermodynamic entropy.
   - The expression for the change of the entropy on isothermal expansion of an ideal gas.
   - State the second law of thermodynamics.
   - Calculate the change of entropy when a system is heated.
   - Calculate the entropy change during a phase transition.
   - Calculate the entropy change during irreversible processes.
   - Calculate the changes of entropy in the surroundings of a system.
   - Define the Helmholtz function.
   - Define the Gibb's function.
   - Relate the Helmholtz function to the maximum amount of work available from a changing system.
   - Relate the Gibb's function to the maximum amount of non-pV work available from a changing system
   - Evaluate the entropy of a system from thermo chemical data.
State the third law of thermodynamics.
State how the internal energy changes when the entropy changes.
State how the internal energy changes when the volume changes.
Indicate mathematically how the Gibb’s function depends on the pressure and temperature.
Derive the Gibb’s - Helmholtz equation.
State how the Gibb’s function of solids and liquids varies with pressure.
Gibb’s function and the chemical potential of an ideal gas.
Define the fugacity of a gas.
Relate the fugacity of a gas to the pressure of the gas.
Define the standard state of a real gas.
State how the Gibb’s function changes when the composition of a system changes.

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**CLT 235: Organic and Heterocyclic Chemistry**

- Organic and Heterocyclic Chemistry: 5 credits (75 hours); L, T, P, SPW

**General objectives:**
- Know the sources, preparations, properties and uses of heterocyclic aromatic compounds
- Know some named organic reactions involved in synthesis degradation and rearrangement of organic compounds
- Know some synthetic methods and reagents
- Understand the chemistry of organometallic compounds

**Content:**

1. **Sources, preparations, properties and uses of heterocyclic aromatic compounds**
   - Define a heterocyclic compound.
   - List the main hetero atoms as N, O and S.
   - List examples of 5 membered non aromatic monoheterocyclic compounds: tetrahydrofuran, tetrahydrothiophene and pyrrolidine
   - List examples of 5 membered aromatic monoheterocyclic compounds - furan, pyrrole and thiophene.
   - Give an example of 6 membered monoheterocyclic compounds - pyridine.
   - Draw the structures of furan, thiophene, pyrrole and pyridine.
   - State Hantzch Widman rules for naming heterocyclic compounds
   - Name heterocyclic compounds applying the rules above.
   - Explain the basicity of pyridine, pyrrole and pyrrolidine
   - Explain why aromaticity increases in the order: furan pyrrole, thiophene, benzene, pyridine.
   - Describe the Paal Knorr synthesis of furan, pyrrole, and thiophene.
   - Describe the mechanism for Paal Knorr synthesis.
   - Describe the physical properties of furan, pyrrole and thiophene.
   - Describe the Hantzsch synthesis of pyridine
- Describe the mechanism of the Hantzsch synthesis
- Describe the following for 5 and 6 membered monoheterocyles:
  - Electrophilic substitution at carbon atoms - Nitration, sulphonation, halogenation, acylation, diazocoupling, nitrosation and mercuration.
  - Mechanism of the above reactions and explanation of the regioselectivity
  - Reactions with acids - ring opening, polymerization, picrate formation and oxidation.
- List examples of 5 membered polyheterocyclics like imidazole, thiazole, pyrazole, oxazole and examples of 6 membered poly heterocyclics as pyrazine, pyrimidine and pyridazine.
- List polycyclic derivatives of 5 membered ring systems like indole, benzo-furan, benzathiphene, carbazole and 6 membered polycyclic derivatives like acridine.
- Describe the occurrence of indole, and the indole alkaloids
- Describe the methods of synthesis of indoles:
  - the Fisher indole synthesis
  - the Bishchier indole synthesis
  - the Madelling indole synthesis
- Explain the chemical properties of indole - oxidation, addition reaction, substitution reaction, reduction reaction, Erlich test.
- State the sources of quinoline.
- Describe the Skramp's synthesis of quinoline from amylamines and \( \alpha \)-unsaturated carbonyl compounds.
- Explain the chemical properties of quinoline - nitration, sulphonation, halogenation, oxidation, reduction.
- Describe the relationship between quinoline and quinine, and the use of quinine to treat malaria

2. Organic reactions involved in synthesis degradation and re-arrangement of organic compounds
- Describe Gabriels' synthesis of primary amines.
- Describe Arndt-Eistert, and Baeyer - Villiger reaction for the synthesis of carboxylic acids.
- List examples of peracids as oxidizing agents in the Baeyer Villiger reaction such as perbenzoic acid, peracetic acid.
- Explain why Baeyer-Villiger reaction is applicable to aliphatic and aryl ketones without double bonds.
- Describe Aldol, Claisen, Beckmann and Perkin condensation reactions.
- Explain the Sandmeyer and Gattermann's reaction of the displacement of diazomium groups.
- Describe Friedel-crafts alkylation and acylation; Haller-Bauer alkylation.
- Describe Wittig reaction.
- Describe Diels-Alder reaction
- Describe Walden inversion in the reaction of bases with alkylhalides.
3. **Synthetic methods and reagents**
   - Describe methods of formation of c-c bonds by the use of Organometallic reagents, base catalysed and acid catalysed condensation reactions.
   - List reagents for organic synthesis such as Grignard reagents (RMgBr), strong bases (e.g. NaOH, NaNH₂ etc), acetoacetic ester, diethyl malonate, phosphonium and sulphorium ylids, peracids.
   - Describe the use of enamines and protecting groups for organic synthesis.

4. **Chemistry of Organometallic compounds**
   - Define an organometallic compound.
   - List examples of organometallic compounds.
   - List and describe physical and chemical properties of organometallic compounds.
   - Describe the preparation of organometallic compounds (Grignard reagent RMgBr).
   - Apply Grignard reagent to organic synthesis.
   - Describe the reactions of Grignard reagents with organic halides (both alkyl and benzyl halides, alcohols, ketones, acid chlorides, esters, epoxides, and amides).
   - Describe the preparation of organosodium, organolithium and organocadmium compounds.
   - Compare the reactivities of compounds in 4.7 above with Grignard reagents.
   - Describe the preparation of zinc-alkyls.
   - Discuss the use of zinc-alkyls in synthesis by using appropriate examples.
CLT 236: Analytical Chemistry II: 4 credits (60 hours); L, T, P, SPW

- Analytical Chemistry II: 4 credits (60 hours); L, T, P, SPW

General Objectives:
- Understand the principles, design, operation and applications of immunoassays
- Understand the basic principles and applications of automation in the laboratory
- Understand the general principles, operation and applications of electroanalytical methods.

Content:

1. **Principles, design, operation and applications of immunoassays**
   - Understand the principles of immunoassays
   - Discuss the types of labels used in immunoassays: radiolabels, enzymes, fluorescence.
   - Discuss the different techniques used to separate bound analyte from free: dextran-coated charcoal, second antibody, immobilisation
   - Understand the practical aspects of immunoassays including: preparation of hapten-carrier conjugates, immunisation, antibody detection, antibody titres, calibration, matrix effects
   - Discuss the shape and precision of standard calibration curves, including precision profiles
   - Discuss the advantages and disadvantages of immunoassays in terms of time, sensitivity, selectivity etc.
   - Discuss the factors involved in developing an immunoassay
   - Discuss the use of affinity chromatography as an immunoassay.
   - Discuss immobilisation and elution techniques used with affinity chromatography
   - Briefly discuss possible future directions for immunoassay

2. **The basic principles and applications of automation in the laboratory**
   - Discuss the processes occurring in an analysis that may have automation possibility
   - Discuss the difference between discrete analysers and continuous flow analysers
   - Understand the principles of flow injection analysis (FIA)
   - Draw a simple schematic of an FIA system
   - Discuss the effects of convection and diffusion on the concentration profile of analytes
   - Discuss applications of FIA including limited-dispersion and medium-dispersion applications, stopped-flow methods and flow injection titrations
   - Discuss principles and applications of automatic samplers
   - Discuss the use of laboratory robots for sample preparation
   - Discuss the advantages and disadvantages of using automated systems for analysis
3. The general principles, operation and applications of electroanalytical methods.
   - Draw a two-electrode cell for use in potentiometry
   - Discuss the basic principles of ion selective electrodes
   - Identify the terms in the Nernst equation
   - Describe the relationship between activity and concentration
   - Discuss the use of Total Ionic Strength Adjustment Buffer so that concentration is equivalent to activity
   - Discuss the effects of interfering ions using the potentiometric selectivity coefficient and the Nickolsky-Eisenmann equation
   - Calculate the percentage error of the ISE due to interference
   - Discuss the types of ISE with examples: glass membrane (pH); solid state membrane; ion exchange and liquid membrane
   - Discuss the use of standard additions and working curves to calibrate ISEs
   - Calculate the concentration of samples using the calibration methods in 3.8 above
   - Discuss the use of potentiometry in titration
   - Discuss the principles of amperometry and amperometric titration
   - Draw a diagram of the equipment used for an amperometric titration
   - Discuss the advantages of membrane and membrane-covered electrodes with examples
   - Discuss the use of modified electrodes with examples
   - Discuss the principles of voltammetry
   - Draw a schematic of a system for potentiostatic three-electrode linear-scan voltammetry
   - Discuss the principles of the electric double-layer
   - Describe the shape of the voltammetric curve for reversible and irreversible reactions
   - Understand the effect of charging current on the measurement and how to compensate for this
   - Explain the term diffusion current
   - List factors that affect the diffusion current
   - Understand the terms peak potential, half-wave potential, residual current
   - Discuss the use of square wave voltammetry and describe the waveform used
   - Discuss the principles of stripping voltammetry
   - Understand the principles of the electrodeposition step
   - Understand the difference between anodic, cathodic and adsorptive stripping voltammetry
   - Discuss the advantages of using stripping voltammetry
   - Explain the differences between using the peak height and peak area for calculation of a concentration.
- Calculate the concentration of a sample, using working curve and standard addition methods, analysed using stripping voltammetry
- Discuss the principles of polarography
- Understand the terms in the Ilkovic equation and how this affects diffusion current
- Discuss the two main types of pulse polarography techniques: differential pulse polarography and square-wave polarography
- Discuss the organic and inorganic applications of polarography
- Discuss the use of hydrodynamic electrodes
- Discuss the types of hydrodynamic electrode including rotating disk (RDE), wall jet, dropping mercury electrode (DME), tube and channel
- Draw schematic profiles of streamlines at these electrodes
- Understand the relationship between the limiting current and diffusion layer thickness using the equation 
  \[ IL = \frac{nFAD}{\delta} \]
- Describe the characteristics of the DME
- Draw a diagram of the apparatus for a DME
- Understand the terms used in the Cottrell equation
- Discuss the advantages and disadvantages of the DME
- Discuss applications of the DME
- Discuss the use of RDEs to investigate the kinetics of reactions
- Discuss the types of double hydrodynamic electrodes including rotating ring disk electrode (RRDE), wall jet ring-disc electrode (WJRDE) and the tube/channel double electrode (TDE/CDE).
- Discuss the use of double electrodes to investigate electron transfer
- Discuss the principles of microelectrodes
- Understand the difference in diffusion to a microelectrode when compared with a macroelectrode
- Compare the voltammetric response of a microelectrode with that of a standard macroelectrode
- Discuss the types of microelectrode configuration including disk, cylindrical, band, and ring.
- Discuss factors involved with the construction of microelectrodes

- CLT 237: Civic Education and Ethics/ Initiation to the Law

  - Civic Education and Ethics

    The Concept:
    - The citizen;
    - The Nation;
    - The State;
    - Publics Property unto collective 'sgoods;
    - The freedoms;
    - The public service;
    - Ethics;
Initiation to the Law:

Objective: At the end of this course, students should be able to identify and explain some fundamental principles of business law, distribution law, labour law and intellectual property law. Students are equally expected to understand the rules and legal provisions regarding the internal and external operations of a corporate body including the powers of executive.

Courses Content

1. Business Law;
2. Distribution Law;
3. Labour Law;

CLT 241: Forensic Biochemistry

Forensic Biochemistry: 5 credits (75 hours); L, T, P, SPW

General Objectives:
- Understand the metabolism of foreign compounds (Xenobiotics) in the body.
- Understand the analysis of materials of forensic interest.

Content:

1. The metabolism of foreign compounds (Xenobiotics) in the body.
   - Describe drugs as foreign chemical compounds in the system.
   - Classify drugs as acidic, basic and neutral.
   - Explain the role of the liver enzymes in foreign compound metabolism.
   - Describe the characteristics of foreign compound metabolizing enzymes.
   - Explain the role of the smooth Endoplasmic reticulum in foreign compound metabolism. Explain the two phases in the metabolism of foreign compounds (phase I and II).
1. Explain the reason and the effects of drug metabolism
2. Explain how the effect (metabolism) of a drug in the system depends on such factors as the structure of the compound route of administration, sex and strain and species of animal, presence of other chemicals, diet etc.
3. Explain the terms: toxicity, carcinogenicity, mutagenicity teratogenicity etc.
4. Explain the effects of drugs on tissues in terms above.
5. Describe the various routes of excretion of drugs and their metabolites (breakdown products) e.g exhaled air, sweat, saliva, urine, bile and other body fluids.
6. Explain the importance of the study of rate of urinary excretion of drugs in forensic science.
7. Explain drug-drug interactions in the body.

2. **Analysis of Materials of forensic interest.**
   1. Explain forensic science.
   2. Describe the collection, preservation and forwarding of materials of forensic interest to the laboratory.
   3. Explain the need for proper storage of materials for forensic analysis.
   4. Explain the importance of preserving some portions of a sample for further reference.
   5. Describe the duties of the toxicologist.
   6. Describe the various groups of poisons.
   7. Explain the methods of extraction and identification of compounds of forensic interest.
   8. Describe the extraction and identification of poison and drugs.
   9. Explain metallic poisoning, indicating where they are deposited in the body.
   10. Describe the methods of extraction and specific identification of 2.9 above.
   11. Describe blood groups and rhesus factors.
   12. Explain blood group typing and parentage dispute as well as their relationship.
   13. Describe the various types of body fluids.
   15. Describe various presumptive (preliminary) tests employed on body fluids (e.g. blood; saliva, serum) before specific confirmatory tests.
   16. Explain species identification for blood strain.
   17. Carry out test on blood stains, saliva, smina stains and species identification.
   18. Define and classify hard drugs.
   19. Describe methods of purification of such hard drugs and compare results with the normal level (data) set by Nigerian standards.
organization, food and Drug administration (FDA) and World Health Organisation (WHO) and similar bodies.

- Describe standard confirmatory methods of analysis of hard drugs.
- Describe spot test for drugs of forensic interest.
- Make proper deductions from all available data.
- Build up result/data banks for future references.
- Explain presentation pattern of work reports.
- Explain why the analyst must report only his findings.

**CLT 242: Food Chemistry and Brewing**

- **Food Chemistry and Brewing: 4 Credits (60 hours): L, T, P, SPW**

**General Objectives:**
- Understand the major classification of food and food preservation techniques
- Know some basic biotechnology of food
- Understand the chemical principles and processes involved in beer brewing

**Content:**

1. **Classification of food and food preservation techniques**
   - Classify Foodstuff in terms of origin of raw materials i.e. plant and animal sources.
   - List the raw material sources
   - Describe some industries based on above.
   - Describe some industrial processes of food preservation i.e. freezing, sterilization, curing, canning, drying etc.
   - Describe industries based on further processing of products above: bread, confectionary, beverages, margarine, dairy products etc.
   - List some common food additives.
   - Classify 1.6 above as colourants, flavours, preservatives, gelling and emulsifying agents, sweeteners etc.
   - Describe the significance of food additives.
   - List causes of food spoilage - bacterial, fugalvia insects and enzyme activity.
   - Describe ways of prevention of food spoilage(freezing, sterilization, drying etc.)
   - Explain the occurrence and significance of browning reactions
   - Describe the mechanism of browning reactions and distinguish between enzymic and non-enzymic browning in foods
   - Explain the various methods of controlling or inhibiting browning in foods, explain the occurrence of carbohydrates in plant foods
   - classify the different carbohydrates found in food
   - Explain the preparation of syrup from invert sugar
   - Explain the various types of polysaccharides - starch, celluloses, pectic substances, gums and mucilages and their significance in the food industry
1. Chemical principles and processes involved in beer brewing
   - List raw materials use in brewing.

2. Biotechnology of food
   - Explain the meaning and origin of the term biotechnology
   - Explain the significance of biotechnology in the food industry
   - List and classify the major enzymes used in food and in the food industry
   - Explain the significance of the various classes of enzymes in the production of food products
   - Explain enzyme immobilization and its application in food industry
   - Explain the importance of enzymes in food analysis.

3. Chemical principles and processes involved in beer brewing
   - List raw materials use in brewing.
- State why starch is the useful chemical constituent of the raw materials above.
- List local sources of starch for brewing.
- Describe methods of extraction of starch from the raw materials listed above.
- Explain how starch based glucose syrup is produced by the methods above.
- Define the term “fermentation”.
- List enzymes used in brewing.
- Explain how fermentation of glucose syrup leads to the production of beer.
- Describe limited and complete fermentation reactions.
- List industrial applications above.
- Describe commercial extraction, purification, storage and recovery of enzymes/yeast.
- Outline the processes of production of beer.
- Describe the chemical and biochemical techniques in the quality control of beer.

**CLT 243: Medicinal Chemistry**

- **Medicinal Chemistry: 4 credits (60 hours); L, T, P, SPW**

**General Objectives:**
- Understand some of the historical background to the discovery and use of drugs
- Understand basic concepts in the study of drugs and medicines
- Understand drug action at enzymes
- Understand drug discovery and development
- Understand pharmacokinetics

**Content:**

1. **Historical background to the discovery and use of drugs**
   - Describe briefly the history of opium and its use in medicine
   - Describe the isolation and initial medical uses of morphine
   - Discuss the elucidation of the structure of morphine
   - Understand the simple lock and key mechanism for morphine binding to receptors on the surface of nerve cells
   - Discuss the structures and properties of 6-acetyl morphine, 3,6-diacetyl morphine, codeine and dihydrocodeine
   - Know the history of bacteria and some antibacterial agents
   - Understand that Ehrlich initiated chemotherapy
   - Describe the discovery of Salvarsan, proflavine and prontosil
   - Describe the history of penicillin
   - Know the parts played by Flemming, Florey, Chain and Hodgkins.
   - Draw the structure of penicillin
   - Explain the lability of penicillin
• Use curly arrows to draw the mechanism of the base promoted hydrolysis of penicillin
• Use curly arrows to draw the mechanism of the acid catalysed hydrolysis of penicillin
• Know that penicillin inhibits an enzyme involved in constructing the cell wall of bacteria

2. Basic concepts in the study of drugs and medicines
• Understand that drugs may be classified (a) by their pharmacological effect, (b) by their chemical structure, (c) by their intended target or (c) by their site of action
• Know basic cell structure
• Know that drugs produce their effects by interacting with proteins (receptors, enzymes, etc) nucleic acids (DNA) lipids (cell membranes) and structural carbohydrates.
• Understand (revise) the structure of proteins and discuss the interaction of drugs with receptor binding sites.
• Describe receptor recognition and binding of drugs in terms of: specificity, complementarity of shape, complementarity of electronic nature and the types of binding forces available
• Explain stereospecificity in drug-receptor binding

3. Drug action at enzymes
• Understand (revise) chemical catalysts and catalysis
• Understand (revise) enzymes as catalysts
• Understand (revise) enzyme kinetics
• Describe substrate binding by enzymes
• Describe molecular mechanism of catalysis for an enzyme
• Discuss competitive inhibitors
• Discuss non-competitive (irreversible) inhibitors
• Understand non-competitive, reversible (allosteric) inhibitors
• Discuss the catalytic role of enzymes in terms of substrate binding, molecular mechanisms of catalysis (general acid/base, nucleophilic groups, transition state stabilisation)
• Give examples of enzyme inhibitors as antibacterial drugs
• Give examples of enzyme inhibitors as antiviral drugs
• Give examples of enzyme inhibitors against the body's own enzymes

4. Drug discovery and development
• Discuss the screening of natural products to find new drugs
• Describe the exploitation of medical folklore
• Describe the screening of synthetic "banks" of compounds
• Discuss starting from a known lig and such as a hormone
• Discuss the role of serendipity and the prepared mind
• Understand the saying that "drugs are discovered in the clinic"
• Discuss structure-activity relationships and the binding role of: hydroxyl groups, amino groups, aromatic rings, double bonds, carbonyl groups, and amides
- Define isosteres and give examples
- Discuss drug design to: increase activity, reduce side effects, improve pharmacokinetics (absorption, metabolism and excretion), improve synthesis and factory production
- Discuss the variation of substituents in drug development
- Discuss chain extensions and contractions
- Discuss ring expansions and contractions
- Discuss isosteric replacements, discuss rigidification of the structure

5. Pharmacokinetics
- Outline how drug liberation, absorption, distribution, metabolism and excretion are effected in an organism
- Discuss the design of drugs to influence their: chemical stability and metabolic stability
- Discuss drug design to optimise distribution by changing the balance of: hydrophobicity, hydrophilicity, charge, polarity
- Discuss the design of drugs to confer resistance to chemical hydrolysis and metabolic transformations
- Describe some methods of targeting drugs to their site of action
- Describe some examples of prodrugs and how they work
- Discuss common methods of administration of drugs
- Discuss the formulation of drugs

📚 CLT 244: Electrochemistry and Photochemistry

➢ Electrochemistry and Photochemistry: 4 credits (60 hours); L, T, P, SPW

**General objectives:**
- Understand the behaviours of ions in solution
- Understand the nature of electrochemical cells
- Understand the phenomenon of ion transport and molecular diffusion.
- Understand photochemical reactions

**Content:**

1. **The behaviors of ions in solution.**
   - Define the following - activity, activity coefficient and the mean activity coefficient of ions in solution.
   - Describe the ionic atmosphere.
   - State the role of ionic atmosphere in determining the value of the mean activity.
   - State the form of a shielded coulomb potential
   - Define ionic strength.
   - State and derive the Debye- Huckel limiting law for the mean activity coefficient.
   - Explain how the Debye- Huckel limiting law may be extended to more concentrated solutions.
   - Define the electrochemical potential of an ion.
- Derive an expression for the potential difference across an interface in terms of the standard potential difference and the activity of ions.
- Derive an expression for the potential difference across a gas/inert metal electrode.
- Derive an expression for the potential difference across a metal/insoluble salt/ion electrode.
- Describe the construction of metal/insoluble salt/ion electrode.
- Derive an expression for the potential difference at a redox electrode.
- Obtain \( E_{\text{cell}} \) from data using the expression above.
- Describe the formation of a liquid junction potential.
- Derive an expression for the potential difference across a membrane.
- Describe the construction of a cell with a liquid junction and a cell without a liquid junction.

2. **The nature of electrochemical cells.**
   - Define thermodynamic reversibility of an electrochemical cell.
   - Define electrode potential and describe the sign convention.
   - Relate the e.m.f of a cell to the spontaneous direction of change of the cell reaction.
   - Define the term standard e.m.f.
   - Derive the Nernst equation for the concentration dependence of the e.m.f. of a cell.
   - Relate the standard e.m.f. to the equilibrium constant of the cell reaction.
   - Describe the method of measuring standard electrode potentials.
   - Describe the measurement of activity coefficients.
   - Relate the temperature dependence of the e.m.f. to the entropy of a cell reaction.
   - Define solubility product and deduce its value from e.m.f. data.
   - Describe the electrochemical basis of a potentiometric titration.
   - List the applications of electrochemistry e.g. corrosion, protection etc.

3. **The phenomenon of ion transport and molecular diffusion.**
   - Define conductivity and molar conductivity of solutions.
   - Explain how conductivity and molar conductivity of solutions can be measured.
   - State Kohlrausch’s law of independent migration of ions.
   - Calculate the molar conductivity of a solution using 3.4 above.
   - State Oswald’s dilution law.
   - Use 3.6 to calculate the molar conductivity of weak electrolytes using Oswald’s dilution law.
   - Define the drift velocity and the mobility of ions.
   - Relate molar conductivity to ion mobility.
   - Define the transport number of an ion.
   - List the factors that affect the mobility of ions.
   - State the basis of the Debye-Huckel – Onsager equation.
   - Define a thermodynamic force.
- Derive the diffusion equation and use it to describe the diffusion of a solute into a solvent.

4. **Photochemical reactions.**
   - Explain the influence of light on chemical system.
   - Define quantum yield efficiency.
   - Calculate the quantum yield efficiency of a photochemical reaction from a given data.
   - Derive rate laws for a given photochemical reaction.
   - Define photo stationary state.
   - Define fluorescence, phosphorescence and chemiluminiscence.
   - State the importance of photosensitized reactions.

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**CLT245: Natural Products and Stereochemistry**

- **Natural Products and Stereochemistry: 4 credits (60 hours): L, T, P, SPW**

**General objectives:**
- Understand the different forms of spatial arrangement of atoms in molecules and differentiate between the various types of stereoisomers
- Understand the sources and chemistry of some natural products.
- Discuss the extraction of steroids from yams and their conversion by partial synthesis into medically important steroid drugs

**Contents:**

1. **The different forms of spatial arrangement of atoms in molecules and differentiate between the stereoisomer**
   - Explain the concept of isomerism.
   - Explain the following forms of stereoisomerism:
     - conformational isomerism
     - cis-trans isomerism in alkenes
     - enantiomorphism
   - Define chirality.
   - Explain the interconvertibility of conformers and the non interconvertibility of enantiomers (except via chemical reactions)
   - Explain optical activity of enantiomers.
   - Define specific rotation.
   - Write equation for calculating specific rotation.
   - Describe parameters that affectspecific rotation.
   - Define absolute configuration.
   - List notations used in absolute configuration.
   - Define racemic mixture and explain racemic resolution.
   - Explain diastereoisomerism and write the equation for the number of stereoisomers in a given compound.
   - Describe meso forms with examples.
   - Know that chiral compounds can not be synthesised from achiral compounds
Know that reaction of a pure enantiomer with an achiral reagent may give rise to a mixture of diastereoisomers in which one diastereoisomer predominates.
Understand that the process involved above may result from steric effects as the reagents interact.
Discuss the phenethanolamines, their extraction from “Ma Huang” and other species of Ephedra.
Discuss the stereochemistries of the various phenethanolamines and their medical uses.

2. The sources and chemistry of some natural products.
- Discuss what chemists mean by the term "Natural Products"
- Describe, in brief outline, the history of the exploitation of natural products.
- Discuss primary and secondary metabolites
- Discuss some of the more important reactions used by nature in constructing natural products.
- Describe the role of cofactors in the biosynthesis of natural products.
- Discuss the elucidation of biosynthetic pathways and the use of labelled precursors and metabolites.
- Explain the meaning of alkaloids with examples.
- Design a plan for the extraction of alkaloids from plant sources.
- Describe the source, chemical structure, physiological activity and biosynthesis of ephedrine.
- Discuss the biosynthesis of selected alkaloids from ornithine and lysine.
- Discuss the biosynthesis and importance of nicotine, tropane alkaloids and cocaine.
- Discuss the biosynthesis of selected alkaloids from phenylalanine and tyrosine.
- Discuss the biosynthesis and importance of: reticulene, thebaine, codeine and morphine.
- Describe the source, chemical structure, physiological activity and biosynthesis of quinine.
- Explain the meaning of Terpenes.
- List broad classes of terpenes.
- Outline the sources of terpenes.
- Discuss the biosynthesis of monoterpenes from mevalonic acid and isopentenyl pyrophosphate.
- Discuss the import monoterpenes: alpha pinene, and thujone.
- Discuss the biosynthesis of: Sesquiterpenes, C15; Diterpenes, C20; Triterpenes, C30 and Steroids.
- Explain the meaning of steroids and list their sources.
- Explain the importance of steroids in the synthesis of sex hormones.
- Describe the synthesis of sex hormones from a named steroid.
- Draw the structures of the following: Testosterone, Progesterone, Estrone, Stillbestrol, Cortocisterone, Aldosterone, Cortisone etc.
- Explain the uses of steroids.

3. **Extraction of sapogenins from yams and their conversion by partial synthesis into medically important steroid drugs**
   - Discuss the expense of producing steroid drugs by total synthesis
   - Describe the search for natural sources of steroids from plants (to be used as raw materials for the synthesis of drugs)
   - Describe the discovery in yams of sapogenins with a "steroid-like" structure
   - Describe the conversion of diosgenin, by partial syntheses, into progesterone and androstenedione
   - Describe the conversion of androstenedione into estrone.
   - Discuss the stereochemistry resulting at centres produced by the above reactions and introduce the concept of stereospecific and stereoselective reactions.
   - Give examples of stereoselective reactions in the organic chemistry of steroids

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**CLT246: Professional internship**

- Professional internship : 6 credits (90 hours); P, PW

  1. Arrival and integration in the enterprise
  2. Working in a company
  3. Holding of the Internship journal
  4. Choice of the theme of work in collaboration with the professional trainer and the academic supervisor
  5. Elaboration of the canvas of research
  6. Resources to exploit
  7. Organization of work
  8. Drafting of the report
  9. Presentation of the report before a jury

- **Methodology of writing an internship report**
  - **A. Drafting and structuring of probation report**
    1. **General Approach**
       - Nature and contents of internship report;
       - Paragraph;
       - The style and spelling.
    2. **Structuring of the document**
       - Cover;
       - Acknowledgments;
       - Heading of the probation report;
       - Executive Summary;
       - List of figures and tables;
       - Glossary;
• Body of the report of internship;
• Bibliography;
• Annexes;
• Summaries and keywords.

B. Formatting of the probation report

1. General information
   • Remission of the probationary report;
   • Choice of software.

2. Rules of presentation
   • Size of the probation report;
   • Page layout;
   • Families of fonts;
   • Sizes and styles of fonts;
   • Spacings and pagination.

3. Notes at the bottom of the page

4. Floaters
   • Tables;
   • Figures;
   • List of figures and tables;
   • Equations;
   • Glossary.

5. Bibliography
   • Purpose of the bibliographical quotations;
   • Format of bibliographical quotations; pop-up
   • List of bibliographical references;
   • Bibliographical references for electronic documents.

❖ CLT 247: Accounting and Economics

➢ Accounting: 1 credit (15 hours); L, T, SPW

A. General Ledger

1. The Company and its heritage
   • Concept of the enterprise;
   • Balance sheet and its variations.

2. Analysis of the current operations of the company
   • Concept of jobs resources;
   • The Accounting transfer;
   • From accounts to balance.

3. The operations of purchases and sales
   • Billing;
   • Accounting registration;
   • System of inventory;
   • Stock form.

4. The regulations on term: the effects of trade
   • Definition;
   • Principles;
5. The depreciation and amortization
   - definition;
   - accounting registration;
   - typology.

B. General introduction to the Financial Analysis

1. Analysis of the balance sheet
   - Summary presentation of the balance sheet.

2. Study of the structure of the balance sheet
   - Calculations of ratios.

3. Functional analysis of the balance sheet
   - Definition;
   - Principles;
   - Computations;
   - Table of differential exploitation.

4. Differential analysis of the balance sheet
   - Definition;
   - Principles;
   - Computations;
   - Table of differential exploitation.

C. Analytical management accounting

1. Generality on the cage
   - Objective;
   - Role;
   - Concept of burden.

2. Analysis of expenses
   - Liable burden
   - Direct and indirect expenses;
   - Valorization of stocks.

3. Method of full costs
   - Cost of purchase;
   - Cost of production;
   - Cost of returns;
   - Calculation of the result.
Economics: 2 credits (30 hours); L, T, SPW

1. Notions of general economics
   - Introduction;
   - Consumption and production;
   - The raising of income;
   - The currency and credit;
   - The prices;
   - The concept of growth and development.

2. The Company
   - Introduction;
   - Typology of enterprises;
   - Structure and organization of the enterprise;
   - The company and ethics;
   - How to undertake (create, decide, manage).

3. The place of the company in the economic fabric
   - Concept of the environment of the company;
   - The inter- and extra-enterprises relationships;
   - The commercial activity;
   - The notion of strategy.

4. The productive activity
   - The policies and processes of production;
   - The trade policies;
   - Logistics.

5. The concept of management in the company
   - The activity and financial resources;
   - The planning and management of human resources;
   - The planning and the management of material resources.

6. Information and Communication in the Enterprise
   - Role of information and communication;
   - Collection and organization of information;
   - Strategic diagnosis;
   - Decision System

The Minister of Higher Education
Pr. Jacques FAME NDONGO
Field: BIOLOGICAL ENGINEERING

Specialty: AGRICULTURAL BIOTECHNOLOGY
1. The objective of the training

ABT objective is to train senior technicians in order to be able to develop skills on biotechnology (growing, numeration, separation, concentration, isolation and purification of biological agents). They must know how to work with living organisms (plants, animals, fungi and other microorganisms) using techniques such as propagation, description, observing, counting and the techniques of obtaining a product, preparing media, identifying and purifying biological agents or biomolecules. They must also be able to apply an experimental design, collect data, and are be involve in the exploitation of results in industrial production but also in research and development in various areas such as agriculture, animal husbandry, fishing, food science, soil and environmental sciences. This training should also prepare students for employment in related works such as production, quality control, management and marketing in the bio-industries and also self-employment.

2. Research Skills
   
   → Generic skills
   - Work in autonomy, collaborate as a team;
   - Analyse, synthesize, a professional document (French, English);
   - Communicate orally or written comprehensive language, in business (French, English);
   - Participate in / conduct an approach to the management of the project;
   - Know and exploit the professional networks and institutional sectors of the agricultural biotechnology.

   → Specific skills
   - Perform basic lab operations such as microbiological techniques (media preparation, isolation, purification, observation through a microscope, growing and counting microbes), biochemical techniques (quantification, quality analysis, quality control) and assist the head of the laboratory;
   - Conduct an experiment (tests in farm, in greenhouse, growth chamber, or fermenter), collect, introduce in a computer, provide and save scientific information’s;
   - Follow up and supervise unskilled laborers in his field of competency;
   - Be able to apply a follow up register in order to manufacture bio-products.
3. Career opportunities

- Work as laboratory technician for private, public or other institutions
- Manager of biological resources such as microbial strains; seed and planting material banks,
- Assist the engineer, or Head of lab, Researcher or Consultant or Director of production in a factory;
- Associate in Research and Development; or Marketing agent
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course titles</th>
<th>Number of hours</th>
<th>Number Of Credits</th>
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<td>Introduction to Agricultural Biotechnology</td>
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<td>ABT112</td>
<td>General Ecology</td>
<td>35  20  0  5  60</td>
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**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

**Professional courses 60% (4 UC) 18 credits 270 hours**

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<th>Course titles</th>
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<th>Number Of Credits</th>
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<td>ABT113</td>
<td>Biostatistics</td>
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<td>ABT114</td>
<td>General Microbiology and genetics</td>
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<td>ABT115</td>
<td>Basic Laboratory Techniques</td>
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<td>ABT116</td>
<td>Soil Science Techniques</td>
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**Transversal Courses 10% (1 UC) 3 credits 45 hours**

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<td>Communication in Scientific Language for Biotechnology/ Bilingual training</td>
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**Total**

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<td>ABT122</td>
<td>Quality Control, Biosafety and ethics</td>
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**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

**Professional courses 60% (4 UC) 18 credits 270 hours**

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<tr>
<td>ABT124</td>
<td>Introduction to Experimental design</td>
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<tr>
<td>ABT125</td>
<td>Cell culture and Fermentation technology</td>
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<td>ABT126</td>
<td>Industrial Biosciences</td>
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**Transversal Courses 10% (1 UC) 3 credits 45 hours**

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<td>Applied Microbiology</td>
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<td>ABT232</td>
<td>Agricultural Biotechnology Project</td>
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<td>ABT233</td>
<td>Microbial Fertilizers</td>
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<td>ABT234</td>
<td>Organic Fertilizers</td>
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<td>ABT235</td>
<td>Pathology and Pest Management</td>
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<tr>
<td>ABT236</td>
<td>Microbial and Plant Pesticides</td>
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<td>ABT237</td>
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**Fourth Semester**

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<tr>
<td>ABT241</td>
<td>Products processing and added value</td>
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<tr>
<td>ABT242</td>
<td>Animal and fish production techniques</td>
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<td>10</td>
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<tr>
<td>ABT243</td>
<td>Eco-farming for Sustainable agriculture</td>
<td>30</td>
<td>10</td>
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<tr>
<td>ABT244</td>
<td>Basics on Microbial production techniques</td>
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<td>ABT245</td>
<td>Basics on Cropping techniques</td>
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<td>ABT246</td>
<td>Professional Internship</td>
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<tr>
<td>ABT247</td>
<td>Management and Marketing of biotechnology products</td>
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L: lectures; T: tutorials; P: practicals; SPW: students’ personal work
5. Course content

❖ **ABT 111 : Introduction to Agricultural Biotechnology**

- **Introduction to Agricultural Biotechnology: 5 credits (75 hours); L, T, SPW**
  
  Definitions, general biotechnology, micro propagation and plant production, fertilizers and bio-fertilizers, pest control and bio-pesticides, feed production, animal reproduction and food production, genetic diversity and domestication, crops breeding (autogamy, allogamy, asexually propagated crops), various selection methods microbial and enzymatic engineering, biology and genetic engineering, marketing in biotechnology, biotechnology impact for developing countries.

❖ **ABT 112 : General Ecology**

- **General Ecology: 4 credits (60 hours); L, T, SPW**
  
  Basic definitions (from individual to biome), physico-chemical environment, biotic environment, environmental constraints and adaptation, spatial distribution of organisms, rhythms, seasons cycles and ecological successions, majors interactions between organisms, ecological niche theory, behavior as adaptatives strategy, hierarchical organization (from organisms to trophic food chain or network), ecology and society.

❖ **ABT 113: Biostatistics**

- **Biostatistics: 6 credits (90 hours); L, T, P, SPW**
  
  Definitions, basic statistics (experiment, sampling, data collection, mean, standard deviation, variance), statistics for biology and agriculture, abundance, biodiversity, similarity, statistics for quality control, introduction to data management (using a software), examples of applications.

❖ **ABT 114 : General Microbiology and genetics**

- **General Microbiology and genetics: 6 credits (90 hours); L, T, P, SPW**
  
  History of microbiology, definitions, nature of microbial world (eukaryota, bacteria, archea, viruses), microbial structure, major functions and metabolism, classification, basic genetics (genome diversity, chromosome, plasmids, transformation, transduction), microbial growth (requirements, culture media and growth curves), observing microbes (fresh, staining procedure, other procedures), pathogenicity and epidemiology, microbial control (physical, chemical, biotechnology & biosafety, immunity), the laboratory practical (concepts, basic techniques, instrumentation).
**ABT 115 : Basic Laboratory Techniques**

- **Basic Laboratory Techniques: 3 credits (45 hours); L, T, P, SPW**

Types of labs, risks/danger and prevention measures (biosecurity and biosafety), reagents preparation, microbiology techniques (media preparation, sterilization, pasteurization, isolating), separating mixture of constituents (filtration, dialysis, sieving, centrifugation, distillation, extraction), analytical methods (spectrophotometry, chromatography, electrophoresis, immunochemistry, good lab practices and international regulation.

**ABT 116 : Soil Science Techniques**

- **Soil Science Techniques : 3 credits (45 hours); L, T, P, SPW**

Definitions, geology and sols (genesis, soil classification (FAO, US, France), tropical soil properties (structure, texture, solution, nutrients composition and availability, fertility, degradation, agricultural and industrial pollution), soil physical, chemical, biochemical and microbiological methods, soil management and protection, examples of applications.

**ABT 117: Communication in Scientific Language for Biotechnology/ Bilingual training**

- **Communication in Scientific Language for Biotechnology : 1.5 credits (22 hours 30 MIN); L, T, SPW**

Why learning scientific language for biotechnology?
Initiation to scientific writing (experiment, report, abstract), speaking, oral communication (preparing a presentation, non-powerpoint or powerpoint), poster or picture preparation methods, alternatives methods (participatory), simple agricultural biotechnology for the tropics, examples of applications.

- **English : 1.5 credits (22 hours 30mn)); L, T, SPW**

  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication
  4. **Autonomous reading of "writings" of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
• Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. Write clear, detailed texts
   • Essay writing;
   • Application for employment;
   • C.V;
   • Letter of motivation;
   • Letter/memo writing and minutes of a meeting

➢ French : 1.5 credits (22 hours 30mn)); L, T, SPW

1. Vocabulaire
   • Vocabulaire du matériel de technologie agro-alimentaire
   • Vocabulaire des produits agro-alimentaires
   • Vocabulaire des activités agro-alimentaires
   • Vocabulaire des actants
   • Vocabulaire des affaires

2. Grammaire
   • Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   • De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   • Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   • Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   • De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   • Des fonctions grammaticales.

3. Expression et communication
   • Compréhension et interaction au cours d’une discussion technique ;
   • Communication orale courante ;
   • Communication orale interactive ;
   • De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
   • Lecture rapide et compréhension de texte ;
   • Synthèse de texte
   • De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
   • Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
   • Expressions figées
ABT 121: Basic Microbial Ecology

- Basic Microbial Ecology: 5 credits (75 hours); L, T, P, SPW
  Definitions, I-ecological factors (climatic, edaphic, water, habitat), II-biological factors (plant attributes, animal attributes, macrofauna&other organisms, microflora), ecological interactions (predation, parasitism, commensalism, symbiosis), nutrient cycles (C cycle, N cycle), ecological functions (photosynthesis, decomposition, mineralization, fixation, assimilation, immobilisation), III-Socio-economics of microbe ecology for the tropics, examples of applications.

ABT 122: Quality control, Biosafety and ethics

- Quality control, Biosafety and ethics: 4 credits (60 hours); L, T, P, SPW
  Why quality control? Definitions (nutritional and microbiology composition, gustative, safety, toxicology), biosafety and bioethics (agriculture, industry, health, environment sectors), norms and regulations (Codex alimentarius, other norms), agricultural biotechnology quality control, eco-farming quality control (IFOAM norms), examples of applications.

ABT 123: Biotechnology for agriculture

- Biotechnology for agriculture: 5 credits (75 hours); L, T, P, SPW
  Definitions (classic, modern biotechnology, agric biotechnology for the tropics), I-general biotechnology for agro-pastoralism (crops and trees, animal/fishing and aquaculture, beneficial microorganisms), II-initiation on specific biotechnology for agro-pastoralism (genes, genomes, genomics, cloning, recombinant DNA technology and genetically modified organisms), III-biological resources (Access to Benefit Sharing/Nagoya Protocol)m IV-risk analysis and safety in biotechnology (laboratory biosafety and good laboratory practices), examples of applications.

ABT 124: Introduction to Experimental design

- Introduction to Experimental design: 3 credits (45 hours); L, T, P SPW
  Why do we need experimentation?
  Choosing, measuring plot size, measuring volumes, weight, counting, representative sampling strategy (replicates, accuracy: lab, screen house, farm, field): crops, animals, containers and bags, introduction to experimental design (random, bloc, factorial), data collection and management ( making tables pictures and figures), examples of applications.
ABT 125 : Cell culture and Fermentation technology

- Cell culture and Fermentation technology: 4 credits (60 hours); L, T
  Definitions, cell types properties (animal, plant, fungi, bacteria and ‘virus’), growing cells (diversity of media: in vitro, ex vitro), fermentation technology (types, functioning), solid fermentation technology (growing mushroom, producing malt), examples of applications.

ABT 126 : Industrial Biosciences

- Industrial Biosciences : 6 credits (90 hours); L, T, P, SPW
  The market of IB, principles, choosing the best bio-prospection organisms (conventional selection, genetic manipulation), microbial growth, preservation methods, major products and applications (upstream and downstream processing), intellectual property rights (Patents, PBR and EDV), maintenance, propagation and seed technology, local cases applications.

ABT 127 : Computer Science Training/ Entrepreneurship

- Computer science training: 2 credits (30 hours); L, T, P, SPW
  Computer structure, introduction to some basic computer software’s(World, Office, Excel, SPSS, Epi Info, Matlab), using computer software for data analysis, information and data transfer, storage and security, using internet and social networks, examples of applications.

  - Entrepreneurship: 1 credits (15 hours); L, T, SPW
    1. Concept of an entrepreneur
    2. Motivations in the creation of a business
    3. Search for ideas and evaluation
    4. Search for funding
    5. Choice of legal status
    6. Ethical aspects of business

ABT 231: Applied Microbiology

- Applied Microbiology: 6 credits (90 hours); L, T, P, SPW
  Agricultural micro-organisms, basic methods in applied microbiology (media composition and preparation, disinfection, pasteurization, sterilization, filtration, centrifugation, extraction, packaging), agricultural sector, animal and fishing sector, aquaculture sector, food sector, quality control techniques, examples of local applications.
ABT 232: Agricultural Biotechnology Project

Agricultural Biotechnology Project: 3 credits (45 hours); L, T, P, SPW

Project principle, objectives, methodology (material needed, design, protocol), chronogram of activities (logic frame), budget, documentation, Cases studies: listing and studying examples of typical local successful beneficial eco-friendly projects in agricultural biotechnology.

ABT 233: Microbial Fertilizers

Microbial Fertilizers: 5 credits (75 hours); L, T, P, SPW

The market of fertilizers, plant nutritional needs, nutrients deficiency, soil fertility and types of fertilization, problems caused by inorganic fertilizers, microbial fertilizers types (benefits of microbial fertilizers, diversity of microbial fertilizers and functions), nitrogen fixers (rhizobia), phosphorus solubilizers, mycorrhizal fungi, biostimulants, integrated soil fertility management, examples of applications: using and analyzing microbial fertilizers (bacteria nodulating legumes, mycorrhizal fungi, plant growth promoting microorganisms (PGPR)).

ABT 234: Organic Fertilizers

Organic Fertilizers: 4 credits (60 hours); L, T, P, SPW

Soil fertility and types of organic fertilizers, organic matter decomposition, problems caused by inorganic fertilizers, organic fertilizers types (benefits of organic fertilizers, diversity of organic fertilizers and functions), green manures, garden manures, animal manures, composts, integrated soil fertility management, examples of applications: using and analyzing organic fertilizers (manures, compost, others).

ABT 235: Pathology and Pest Management

Pathology and Pest Management: 4 credits (60 hours); L, T, P, SPW

Origin of plant and animal pathology, nature, reproduction and dissemination of organisms causing pests and diseases, and zoonosis, alien and invasive pests and diseases, basic diagnostic (deficiencies, pests and diseases), weeds management, plant protection methods (preventing, curative: chemical, genetic, biocontrol, integrated), pesticides dangers, safety and quarantine, regulation and phytosanitary norms, veterinary norms, examples of applications: biological management of pest and diseases.
**ABT 236: Microbial and Plant Pesticides**

- **Microbial and Plant Pesticides: 5 credits (75 hours); L, T, P, SPW**

The market of pesticides, biology and biochemistry of plant pesticides, problems caused by industrial pesticides, major plant pesticides, microbial pesticides (bioinsecticides, biofungicides, antibacterial and antivirus pesticides, bionematicides, bioherbicides), examples of applications: working with bio-pesticides in the tropics (bio-insecticides, bio-fungicides, others).

**ABT 237: Civic Education and Ethics/ Initiation to the Law**

- **Civic Education and Ethics: 1.5 credits (22 hours 30 min);**
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property unto collective's goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem;
  - Management and ethics of responsibility;
  - Ethics and management.
  - Codes of ethics
  - Civics
  - Deontology
  - Moral consciousness
  - The universal declaration of Human Rights
  - Good governance in public services
  - Explain the importance of civics to the life of the nation
  - Functions of the state and its citizens
  - Deontology, Professional ethics and professionalism
  - Protection of the environment
  - Some moral figures through national and foreign history

- **Initiation to the Law: 1.5 credits (22 hours 30 min);**

  **Objective:** At the end of this course, students should be able to identify and explain some fundamental principles of business law, distribution law, labour law and intellectual property law. Students are equally expected to understand the rules and legal provisions regarding the internal and external operations of a corporate body including the powers of executive.

  **Courses Content**
  1. Business Law;
  2. Distribution Law;
3. Labour Law;

**ABT 241: Products processing and added value**

- **Products processing and added value**: 4 credits (60 hours); L, T, P SPW
Definitions, principles, processing a product, adding value to a product, market benefits of added value. Cases studies: listing and studying examples of typical local products processing and added value.

**ABT 242: Basics on Animal and fish production techniques**

- **Basics on Animal and fish production techniques**: 4 credits (60 hours); L, T, P, SPW
Definitions, principles, general animal production techniques (conventional agriculture, eco-farming, sustainable agriculture), general fishing techniques, specific animal production and fishing techniques, alternatives to conventional techniques for eco-farming for mitigating climate change, new breeds, animal/crop associations: night paddock manure system, animal and fish disease biocontrol.
Cases studies: listing and studying examples of typical local successful beneficial animal and fish production techniques.

**ABT 243: Eco-farming for Sustainable agriculture**

- **Eco-farming for Sustainable agriculture**: 4 credits (60 hours); L, T, P, SPW
Definitions, principles (conventional agriculture, eco-farming, sustainable agriculture), why adopting eco-farming for the tropics, some typical eco-farming examples, market health and environmental benefits of sustainable agriculture. Cases studies: listing and studying examples of typical local successful eco-farming in agricultural biotechnology.

**ABT 244: Basics on Microbial production techniques**

- **Basics on Microbial production techniques**: 5 credits (75 hours); L, T, P, SPW
Definitions, principles (conventional agriculture versus eco-friendly agriculture), microbial production techniques for the tropics, economic and environmental benefits of microbial products versus chemical or synthetic inputs such as fertilizers, pesticides.
Cases studies: listing and studying examples of typical local successful beneficial microbial uses for agricultural biotechnology.

**ABT 245: Basics on Cropping techniques**

- **Basics on Cropping techniques**: 4 credits (60 hours); L, T, P, SPW
Definitions, principles, general cropping techniques (conventional agriculture, eco-farming, sustainable agriculture), specific cropping techniques, alternatives cropping
techniques for eco-farming: zero tillage, cover crops, eco-irrigation for mitigating climate change, crop rotations, animal/crop associations: night paddock manure system, pest and disease biocontrol.
Cases studies: listing and studying examples of typical local successful beneficial cropping techniques.

**ABT 246: Professional Internship**

- **Professional Internship : 6 credits (90 hours); P**
A report will be made from a practical study on agricultural biotechnology study (with about 20 to 30 pages document) putting a strong emphasis on methodology, illustration of the work done in a professional structure such as private/public company, NGO.

- **Methodology of writing an internship report**

  A. **Drafting and structuring of probation report**
  1. **General Approach**
     - Nature and contents of internship report;
     - Paragraph;
     - The style and spelling.
  2. **Structuring of the document**
     - Cover;
     - Acknowledgments;
     - Heading of the probation report;
     - Executive Summary;
     - List of figures and tables;
     - Glossary;
     - Body of the report of internship;
     - Bibliography;
     - Annexes;
     - Summaries and keywords.

  B. **Formatting of the probation report**
  1. **General information**
     - Remission of the probationary report;
     - Choice of software.
  2. **Rules of presentation**
     - Size of the probation report;
     - Page layout;
     - Families of fonts;
3. **Notes at the bottom of the page**

4. **Floaters**
   - Tables;
   - Figures;
   - List of figures and tables;
   - Equations;
   - Glossary.

5. **Bibliography**
   - Purpose of the bibliographical quotations;
   - Format of bibliographical quotations; pop-up
   - List of bibliographical references;
   - Bibliographical references for electronic documents.

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**ABT 247: Management and Marketing of biotechnology products**

- Management and Marketing of biotechnology products: 3 credits (45 hours); L, T, SPW

Definitions and general principles, initiation to accounting and management, enterprises, Law, human resource management, basic advertising and marketing techniques, biotechnology product development, examples of applications.

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The Minister of Higher Education

Pr. Jacques FAME NDONGO
Field: ELECTRICAL AND ELECTRONIC ENGINEERING

Specialty:

ELECTRONICS
1. The objective of the training

This specialty leads to the training of specialists in charge of the maintenance activities of production systems, energy and fluid systems and wind systems. They provide corrective and preventive maintenance, improve operational safety, manage failures and malfunctions and integrate levels.

2. Research Skills

→ Generic skills
- Work independently and in team collaboration;
- Analyze, synthesize professional documents (French, English);
- Orally and writing communication (French, English);
- Participate in (other) lead project management process;
- Know and exploit professional and institutional networks of electricity sectors.

→ Specific skills
- Analyze existing electronic systems;
- Test and validate of electronic equipment or product;
- Maintain and install equipment or product in operation;
- Apply new technological solutions from the existing and new specifications;
- Detect faults, dysfunctions and establish the repair plan;
- Exchange electronic knowledge.

3. Career Opportunities

- Technician of Maintenance and installation of electronic systems;
- Design office Manager;
- Team leader in production unit;
- Assistant Engineer (measurements, tests and controls);
- After Sales Service Manager.
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
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<th>Course Code</th>
<th>Course titles</th>
<th>Number of hours</th>
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<td>ELN113</td>
<td>Basics of Electricity and Electrical circuit</td>
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<td>Electrical Machines</td>
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### THIRD SEMESTER

**Field: Electrical and Electronic Engineering**

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**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

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**Professional courses 60% (4 UC) 18 credits 270 hours**

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<td>ELN236</td>
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**Transversal Courses 10% (1 UC) 3 credits 45 hours**

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| Total       |                                                    | 225 | 80  | 110 | 35  | 450   | 30                 |

### FOURTH SEMESTER

**Field: Electrical and Electronic Engineering**

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**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

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**Professional courses 60% (4 UC) 18 credits 270 hours**

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<tr>
<td>ELN246</td>
<td>Professional internship</td>
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**Transversal Courses 10% (1 UC) 3 credits 45 hours**

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<th>Course Code</th>
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| Total       |                                                    | 195 | 65  | 70  | 120 | 450   | 30                 |
5. Course content

**ELN 111: Mathematics I: 4 credits (60 hours); L, T, PW**

- Mathematics: 4 credits (60 hours); L, T, SPW
  1. Functions of a real variable.
  2. Circular, hyperbolic, and reciprocal functions.
  5. Taylor Formula and limited developments.
  7. Multiple integrals and their applications to the calculation of area and volume.

**ELN 112: Physics and Chemistry: 5 credits (75 hours); L, T, PW**

- Physics: 3 credits (45 hours); L, T, P, SPW
  1. Kinematics
     - Introduction;
     - Referential system and position vector;
     - Speed and acceleration;
     - Movement in the field of gravity.
  2. Action of forces on a material point
     - Principle of inertia and fundamental principle of the dynamic;
     - The superposition of Forces;
     - The forces of inertia;
     - Friction and friction forces.
  3. Gravitation
     - The force of gravitation;
     - Law of gravitation;
     - Fields of forces.
  4. Work, Power, Energy and Momentum
     - Work;
     - Power;
     - Energy;
     - Momentum.
  5. Action of the forces on a solid body
     - Static;
     - Kinetics of solid bodies.
  6. Fluid Mechanics
     - Fluid and gas at rest;
     - Incompressible liquid.
Chemistry : 2 credits (30 hours); L, T, P, SPW

1. Nuclear Reactions
   - Describe the structure of a nucleus (Mass number, atomic number).
   - Characterization of isotopes;
   - Distinguish the different reactivity (spontaneous and non-spontaneous reaction);
   - Establish the equation of a radioactive transformation;
   - Assess the fault of mass and the energy released by a nuclear reaction;
   - Half-life of the radioactive decay;
   - Activity of radioactive isotopes;
   - Radiation protection;
   - Experimental strategy to quantify the radiation received in function of time, distance and materials crossed.

2. Pure body and mixtures
   - Distinguish between the different types of mixtures (suspensions, emulsions, alloys, aqueous solutions, smoke and fog);
   - Solubility of a solute in a solvent. Homogenous and heterogeneous Solutions;
   - Density of a solution, Molar concentration, Mass concentration, the molarity, molar fractions and mass concentrations.
   - Distinguish between the molar concentration of the normality;
   - Establish and apply the relations between sizes and molar mass quantities;
   - Describe and explain the operation of a process of liquid-liquid extraction;
   - Establish a balance sheet of overall material and partial to each of the constituents of a liquid-liquid extraction;
   - Articulate and apply the law of perfect gases;
   - Define the total pressure and partial pressures for a gaseous mixture;
   - Difference between absolute and relative pressure;
   - Establish the expression and evaluate the density of a real and a perfect gas;
   - Describe and explain the process of extraction liquid-gas: absorption and desorption;
   - Establish a balance sheet of overall material and partial to each of the components of an extraction liquid-gas.

3. Chemical reactions
   - Electronic structure of an atom;
   - Bonding (ionic and covalent bonds);
   - Molecular model of Lewis;
   - Establish an equation of reaction;
   - Establish a molar balance sheet;
   - Standard enthalpy of reaction;
   - Exothermic and endothermic reactions;
4. **Speed of chemical reaction**
   - Set the speed of a reaction by report to a reagent or product;
   - Define the constant speed;
   - Set the order of a reaction by report to a reagent and exploit the equation giving its concentration as a function of time;
   - Define the Time of half-reaction;
   - Identify the factors kinetics: influence of temperature and concentration from follow-up data on the reaction;
   - Explain the role of a catalyst;
   - Operate the curve giving the evolution of a composition of a reagent or a product in the time to identify the order of reaction and evaluate the speed constant and the time to half-reaction.

5. **Reaction in aqueous solution; Acidic, basic and oxido-reduction**
   - Define the specific vocabulary: acid, base according Brönsted, oxidizing, reducer;
   - Oxidation, reduction, torque acido-basic, redox couple;
   - Acido-basic reaction; redox highlighting: exchanges of protons and then of electrons;
   - Establish a link between the powers dissociating, dispersant and solvating of water and its physical properties and molecular structure;
   - Explain the particular case of the water: couples in the water, autoprotolyse, Ke, ampholyte;
   - The reactionsacido-basic;
   - Redox reactions.

6. **Organic chemistry**
   - Identify the gross formulas, developed planes, semi-developed topological and isomers of Simple hydrocarbons (alkanes, Cyclanes, alkenes, benzene) and their derivatives (alcohol, carboxylic acid, aldehydes and ketones) and know the appoint;
   - Establish a link between the structure of a molecule of hydrocarbon and its chemical properties;
   - Distinguish between the three types of reactions in organic chemistry: substitution reactions, addition and elimination;
   - Distinguish monomer and polymer;
   - To distinguish the types of reactions of polymerization;
   - Describe the properties of a few industrial polymers.

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**ELN113: Basics of Electricity and Electrical Circuits**

- **Basics of Electricity and Electrical Circuits** 5 credits (75 h); L, T, PW

1. **Mathematical tools**
   - Elements of vector calculation (coordinate systems, scalar and product, vector product);
   - Scalar Field, Vector Field, and Field Vector Flow.
2. **Electrostatic field and potential**
   - Electrostatic field;
   - Electrostatic potential;
   - Work of an electrostatic force;
   - Distribution of electrical charges;
   - Electric dipole;
   - Electrostatic field flux - Gauss theorem.

3. **Magnetic induction - Ampère theorem**
   - Lorentz force and magnetic induction (Lorentz force, motion of a charged particle in an uniform electric field and in a uniform magnetic field);
   - Magnetic effects of the currents (Laplace and BIOTSAVART Law, Notion of current density);
   - Magnetic flux induction, Ampère theorem;
   - Magnetic induction created by a circular conductor at a distant point, Magnetic moment concept.

4. **Work of electromagnetic forces**
   - Movement of a circuit in a magnetic field;
   - Notion of inductance (self-inductance, mutual-inductance);
   - Applications.

5. **Electromagnetic induction**
   - Displacement of a conductor in a uniform magnetic induction (Electromagnetic field and induced emf, LENZ law, Notion of generator and motor);
   - FARADAY’S induction law (Self-induction, EMF of self-induction, Establishment and extinction of a current in a RL-circuit);
   - Magnetic energy;
   - Applications.

6. **Capacitances - capacitors**
   - Capacitance of an isolated capacitor (Definition, Capacitance of a conducting sphere);
   - Capacitor (Definition, Load carried by the armatures: case of a spherical capacitor to simplify);
   - Grouping of capacitors;
   - Charging and discharging a capacitor through a resistor.

7. **Single phase alternating current**
   - Reminders on complex numbers;
   - Sinusoidal voltages and currents;
   - Ohm’s Law in AC;
   - Dipole in AC;
   - Power in AC systems single phase;
   - Power balance in a circuit - Boucherot's theorem.

8. **Three-phase sources**
   - Balanced sources: sinusoidal voltages and currents;
   - Balanced three-phase loads;
- Unbalanced loads;
- Three-phase AC power

**Electrical circuits : 2 credits (30 hours):L, T, SPW**

1. **Direct current electrical circuit:**
   - Electric dipole: definition, current and voltage as oriented quantities, linear dipole, nonlinear dipole, active and passive dipole, static characteristic, conversion of the senses and energetic behavior, linear resistance and Ohm's law, nonlinear resistance;
   - Methods of analysis of DC linear circuits: Kirchhoff’s laws, Helmholtz’s theorem, mesh currents method, Millman’s theorem;
   - Interaction between an active dipole and a variable passive dipole: voltage, current intensity, power, internal losses, efficiency, power adaptation;
   - Simplification of linear circuits: passive linear circuits (equivalence theorems, Kennelly’s law), active linear circuits (Thévenin’s theorem, Norton’s theorem).

2. **Periodic phenomena**
   - Periodic electrical quantities: period, frequency, continuous value, rms value, active power, oscillation, characteristic ratios of periodic quantities;
   - Sinusoidal electrical oscillations: characteristics (amplitude, pulsation, phase at the origin), average values, superposition, representations (Fresnel vector, complex symbol);
   - Non-sinusoidal electrical oscillations: Fourier series of a non-sinusoidal oscillation, Specific definitions of the non-sinusoidal electrical regime (rms value, active power, apparent power, power factor, reactive power, distortion power, harmonic rate, ripple, etc.), Response of a linear circuit to a non-sinusoidal excitation.

3. **Linear electric circuit in fixed frequency sinusoidal mode:**
   - Notion of linearity of electric dipoles in sinusoidal excitation;
   - Modeling passive linear elementary dipoles: Ohm’s laws, electrical dipole behaviors in sinusoidal excitation;
   - Linear diodes in sinusoidal mode: instantaneous power, active power, apparent power, reactive power, power factor, complex power;
   - Linear circuits in sinusoidal regime: Kirchhoff laws, association of passive elementary dipoles, simplification of passive linear circuits (laws of division of voltage and current, Kerrely's law), resonance, simplification of active linear circuits (power of the source, Thévenin’s theorem, Norton’s theorem), power adaptation, compensation, analysis methods (Kirchhoff’s laws, Helmholtz’s theorem, mesh currents method, Millman’s theorem);
   - Electrical quadrupole concept: parameters, input and output impedances, wave resistance and apparent power matching, image impedances.
4. **Linear electrical circuit and sinusoidal excitation with variable frequency:**
   - Expression of parameters as a function of frequency;
   - Response of a linear circuit to sinusoidal excitation when the frequency varies;
   - Parameter locations and their inversion, transfer function, amplification or gain;
   - Diagram of Bode and Nyquist;
   - Classic filters.

5. **Establishment and interruption of the electric current in a linear circuit:**
   - Switching of a linear circuit (RL, RC, RLC) subjected to a constant voltage;
   - Switching of a linear circuit (RL, RC, RLC) subjected to a sinusoidal voltage.

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**ELN114: Basics Electronic**

- **Basics Electronics : 3 Duration (45 hours); L, T, PW**
  1. Introduction to semi-conductors;
  2. Diodes and Transistors;
  3. The amplification function (ideal operational amplifier, transistors and basic circuit, differential amplifier, analog integrated circuits, awareness to the power amplification, analogical simulation);
  4. Signal generators (comparators and applications, Function generator)
  5. Reliability (failure rate MTBF, failure of electronic components, predictive reliability, use of a compendium of data reliability, reliability of systems, active/passive redundancy, availability of repairable systems)

- **Basis of the digital electronic : 2 Duration (30 hours); L, T, PW**
  1. Basic functions of digital electronics (logical functions);
  2. Combinations of basic functions (; NAND XOR; nor);
  3. Logical Levels;
  4. Numbering Systems and Codes;
  5. Laws and theorems of Boole’s algebra;
  6. Operations on the binary numbers;
  7. Boolean functions;
  8. Simplifications of Boolean functions;
  9. Logic Families, components and applications (MOS technologies, LOS, TTL, …);
  10. TTL components (interfaces, microprocessors, …);
  11. Pulse generators;
  12. Sequential logic (counters, Flip-Flops, registers, clocks, timer, briefs, …);
  13. Comparators, encoders, decoders, multiplexers, demultiplexers;
  14. Achievements (multivibrator oscillator;; Dial counter; counter decimal, …)
ELN 115 : Electronics and Automatism

Automatism and Practical Work: 3 credits (45 hours); L, T, P

A-

Preliminary considerations and essential relating to industrial automation

1. Introduction
   - Definition and Concept;
   - Functions and objectives;
   - Requirement and complexity.

2. The bases of the Boolean algebra

3. Method of analysis
   - Method of chronograms;
   - Method of Karnaugh.

4. Method of Synthesis
   - Synthesis by wired technology;
   - Grafcet Method (Analysis Grafcet);
   - Synthesis and Technologies.

B-

Essential considerations relating to Industrial Automation with programmable technology

1. Definition and Concepts
2. Technology of industrial automation, criteria of choice
3. Industrial Automation API
   - The programmable automation industrial;
   - Hardware and functional organization;
   - Interfacing and extension;
   - Choice of appropriate Automation.

4. Study of an appropriate Automation (according to availability)
   - Architecture and environment;
   - Programming language;
   - Implementation and choice.

5. Practical work in laboratory

Electronic 1 : 2 credits (30 hours); L, T, PW

1. Basical notions of semi-conductors
2. The Diodes
   - Current-Voltage characteristics of the an ideal diode;
   - Current-Voltage characteristics of a real diode;
   - Operating limits;
   - A few special diodes;
   - Notions of operating-point;
   - Applications of diodes.
3. Bipolar Transistor
   - Introduction;
   - Structure and operation;
   - Characteristics of an NPN;
- Operating Limits;
- Notions of operating-point;
- Dynamic model.

4. **Field Effect Transistor (FET)**
   - Introduction;
   - Current-Voltage characteristics;
   - Different Types of FET;
   - A few circuits of polarization;
   - Applications of FET.

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**ELN 116: Construction Design**

- **Construction Design**: 3 credits (45 hours) L, T, PW

1. **Generalities**
   - Generalities on drawing;
   - Dimensional dimensioning of a drawing
   - Connections.

2. **Perspective**
   - Perspective projection of a drawing;
   - Axonometric perspectives.

3. **Projections**
   - Plan reading.

4. **Cuts and sections**
   - Different kinds of cuts;
   - Different kinds of sections;
   - Overall drawing;
   - Drawing for definition

5. **Mechanical connections**
   - Connectors (threaded and unthreaded);
   - Types of links;
   - Characteristics of a link.

6. **Adjustments**
   - Tolerance ratings;
   - Adjustments.

7. **The guides**
   - Translation guidance;
   - Rotational guidance;
   - Blocking concept;
   - Concept of lubrication.
ELN 117: Bilingual training

- **English**: 1.5 credits (22 hours 30mn)); L, T, SPW

1. **Vocabulary**
   - Technical and usual vocabulary of the specialty

2. **Grammar**

3. **Bilingual expression**
   - Understanding in interaction in Technical Discussions
   - Continuous oral communication: Show, explain, develop, summarize, account, comment;
   - Interactions oral communication

4. **Autonomous reading of “writings” of all levels**
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
   - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. **Write clear, detailed texts**
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

- **French**: 1.5 credits (22 hours 30mn)); L, T, SPW

1. **Vocabulaire**
   - Vocabulaire du matériel de technologie agro-alimentaire
   - Vocabulaire des produits agro-alimentaires
   - Vocabulaire des activités agro-alimentaires
   - Vocabulaire des actants
   - Vocabulaire des affaires

2. **Grammaire**
   - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   - Des fonctions grammaticales.

3. **Expression et communication**
   - Compréhension et interaction au cours d’une discussion technique ;
- Communication orale courante ;
- Communication orale interactive ;
- De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
- Lecture rapide et compréhension de texte ;
- Synthèse de texte
- De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
- Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
- Expressions figées

**ELN 121: Mathematics II**

- **Mathematics II : 4 credits (60 hours): L, T, SPW**
  1. Numerical Sequences
  2. Numerical Series
  3. Fourier Series
  4. Laplace transformation
  5. Fourier transformation
  6. Multi-variable functions- Scalar and vectors fields and their applications

**ELN 122: Physics and Computer Science: 4 credits (60 hours); L, T, PW**

- **Physics II: 2 credits (30 hours): L, T, P, SPW**

  **A. Oscillations and Waves :**
  1. **Kinematics of oscillating bodies**
     - Generalities ;
     - The harmonic oscillator;
     - Superposition of oscillations.
  2. **Dynamics of oscillating bodies**
     - Free and damped oscillations
     - Forced and coupled oscillations.
  3. **Waves**
     - Generalities ;
     - Harmonic waves; Groups of waves; Energy transport;
     - The superposition of waves;
     - Reflection, refraction and diffraction of waves;
     - Sound waves and ultrasound.
Computer Science I : 3 credits (45 hours); L, T, P, SPW

1. Generalities and vocabulary
   - Concept of information and informatics;
   - Resolution of problems by the informatics;
   - Typology and computer configuration;
   - Fields of application of informatics;

2. Information representation and processing
   - Systems of numbers;
   - Representation of Numbers and Characters (coding of information);
   - Boolean logic;
   - Circuits of calculations & memory;
   - Presentation and differences between numerical & non-numerical data.

3. Structure and operation of a micro-computer
   - Architectures of a micro-computers;
   - Functional units (Central Unit, Units of entry and exit);
   - Architecture and performance of microprocessors;
   - Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
   - Presentation and roles of programs; their applications.

4. A Computer : An Interface “Machine (Hardware) - Man (Software)” as solutions to problems
   - The bios;
   - The systems of applications;
   - Application programs.

5. Operating systems and examples of operating system
   - WINDOWS (DOS);
   - Linux: an interesting alternative;

6. A few examples of applications software
   - The "Package Microsoft Office" (Word, PowerPoint, Excel);
   - The software of navigation and search engines on the Web.

ELN 123: Information transport and transmission

Information transport and transmission: 4 credits (60 hours) L, T, PW

1. Transmission and transmission of information
   - Transmission of analog and digital signals in basic band
   - Transmission of analog and digital signals in transposed band (carrier frequency
   - Analog modulation and demodulation (AM, FM, PM) and digital (FSK, PSK....)
   - Spectral congestion;
   - Determination of the relationship between the input and the output modulations variable of type AM, FM, PM and FSK;
Other types of modulation:
- Serial or parallel digital data transmission of information point-to-point (RS232, RS 485,...)
- Architecture and organization of networks transmissions; Management mode (protocols, CAN, Ethernet...)

2. **Transmission media:**
   - Calculation in decibels and introduction to the connection assessment
     - Decibels and related units;
     - Weakening and amplification;
     - Level; Noise; Connection Assessment.
   - Microwave link
     - Spread, radiated power, opening, balance sheet of a link;
     - Justify the characteristics of an antenna from a specific requirements.
   - Wired Connection
     - Twisted pair; Coaxial cable;
     - Impedance and Attenuation;
     - Mitigation;
     - Standardization of cables and connectors.
   - Fiber optic connection
     - Mono fiber-mode;
     - Index jumping and Index gradient;
     - Wavelength; Bandwidth;
     - Attenuation;
     - Structure of the cable and Connections;
     - Transducers
     - PIN diode laser.
   - Infra-Red Connection
     - Basics principles in question;
     - Definition of associated units;

**ELN124: Function of analogical electronic and Maintenance**

- **Function of the analogical electronic: 2 credits (30 hours)**
  1. Conventional mounts with the operational amplifiers
  2. Power amplification
  3. Stabilized Power Supplies
  4. Filters
  5. Optoelectronics

- **Maintenance and reliability: 3 credits (45 hours);**
  1. Introduction to the maintenance
  2. Concepts of the maintenance
3. Organization of maintenance
4. Cost of maintenance
5. Maintenance Policy
6. Mathematical tools
7. Methodological tools
8. Software tools

 덫. ELN 125: Power electronics and actuator control

- Power electronics and actuator control: 4 credits (60 hours) L, T, SPW

A. Power electronics
1. Introduction
   - General considerations;
   - Definition and objectives;
   - Different types of power conversion.
2. AC / DC converter
   - Voltage rectifiers (with diodes, single and three-phase thyristors), internal operation;
   - Definition and measurement of input-output quantities;
   - Reversibility.
3. DC / DC converters
   - Power transistors switching;
   - Study of basic choppers (direct link chopper, chopper, reversible chopper);
   - Isolated switching power supplies;
   - Symmetrical power supplies.
4. DC / AC converters
   - Full wave voltage inverters (single-phase, three-phase);
   - UPS in PWM: Principles;
   - Uninterruptible power supply structures;
   - Technologies of storage batteries.
5. AC / AC converters
   - Triacs technology;
   - Study of dimmers;
   - Study of cyclo-converters.
6. Thyristor and Triacs triggering device and circuit
   - DC and AC priming;
   - Pulse priming.
7. Electronic controls of machines
   - Variable speed drive for DC machines;
   - Variable speed drive for AC machines.

B. Actuator control
ELN 126: Practical Work in Electronic

Practical Work in Electronic: 4 credits (60 hours) P
1. Analog Electronics I: 2 Duration (30 hours); P
2. Digital electronics I: 2 Duration (30 hours); P

ELN 127: Business Creation; Civic and Ethical Education

Entrepreneurship: 1 credit (15 hours); L, T, SPW
1. Entrepreneur concept
2. Motivations for starting a business
3. Ideas research and evaluation
4. Financing research
5. Choice of legal status

Civic and moral education: 2 credits (30 hours); L, T
The Concepts
- The citizen;
- The Nation;
- The State;
- Publics Property and collective’s goods;
- The freedoms;
- The public service;
- Ethics;
- Ethics, Law and reason;
- Ethical Problem ;
- Ethics and management.
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics

ELN 231: Mathematics III

Mathematics III: 4 credits (60 hours); L, T, SPW
1. Linear systems
2. Complex numbers
3. Polynomials functions and rational fractions
4. Vector spaces and Euclidean vector spaces
5. Linear applications
6. Matrices

**ELN 232: Physics and chemistry III**

- **Physics III**: 3 credits (45 hours); L, T, P, SPW
  1. **Thermodynamics**
     - Temperature and thermal expansion;
     - Heat and fundamental principle of thermodynamics;
     - Change of state of the ideal gases;
     - Kinetic theory of heat;
     - Cyclical process: 2nd fundamental principle of thermodynamics;
     - Change of state;
     - Propagation of heat.
  2. **Electrodynamics and applications**
     - Currents and fields;
     - Production of magnetic fields;
     - Induction phenomenon;
     - Alternating current;
     - Electromagnetic waves.

- **Chemistry: Basics of Quality, Health, Safety and Environment**: 2 credits (30 h; L, T, P, SPW)
  1. **Management system of a company**
     - Identify the management system of a company using the global standards ISO 9001 and 14001;
     - Use and master the vocabulary of management systems.
  2. **Fight against nonconformities and loop of continuous improvement.**
     - Use and master the vocabulary of continuous improvement;
     - Identify the implementation of the continuous improvement loop, regardless of the domain or company involved: ascertain, isolate / contain, analyze causes, treat causes, measure effectiveness;
     - Identify nonconformities, their degree of severity and their consequences in any context;
     - Propose corrective and preventive actions, even improvement, within the limits of its field of intervention;
     - Respect the rules of traceability within the limits of its field of intervention.
  3. **Risk analysis and prevention.**
     - Participate in a risk prevention analysis;
     - Participate in a dynamic risk impact analysis;
     - Implement a prevention plan or emergency plan in its area of intervention.
4. **Regulations and technical standards.**
   - Situate its action within the framework of the operational technical standards developed by the IEC TC 65: for example the IEC 61508, IEC 61326, IEC 62443, IEC 62424, IEC 62708 series, etc.
   - Recognize the pictograms, hazard classes and precautionary and prevention statements of the CLP Regulation;
   - Apply the rules of prevention, limitation or prohibition related to the REACH Regulation on substances and their uses, whether in the form of raw materials, in mixtures, or contained in "articles";
   - Apply ATEX regulations related to the control of risks related to explosive atmospheres;
   - Comply with the sorting instructions for end-of-life CIRA equipment, issued by the Waste Electrical and Electronic Equipment (WEEE) Directive.

❖ **ELN233: Practical Work Electronic P II**

➢ **Practical Work Electronic P II: 4 credits (60 hours); P, SPW**

1. Practical work: Analog Electronics II: 2 credits (30 hours);
2. Practical work: Digital electronics II: 2 credits (30 hours); P

❖ **ELN234: Robotics and Home electronics**

➢ **Servomechanism and robotics : 2 Duration (30 hours); L, T, SPW**

1. **Servomechanisms**
   - Proceed to the identification of the process by the analysis of the step response of the Open-loop system;
   - System of first order (static gain and time constant);
   - System of the second order (Heartbeat own and coefficient of depreciation) (M<1);
   - System of the second order depreciated (static gain, time constant and dead time of identification) (m>1);
   - System Integrator (gain dynamic, time constant and time natural death);
   - Predetermine the performance in a closed loop from the transfer function in open loop;
   - Experimentally verify the performance of the system looped;
   - For a given corrector, determine the new conditions of operation (precision and stability).

2. **Robotics**
   - Pre-electromechanical actuators;
   - Pneumatic Valves and hydraulic and different types of command;
   - Switch to relay;
   - Variable Speed Drive and control electronics;
- Actuators (electric motor, hydraulic motor, pneumatic engine).

Electronics construction: 3 credits (45 hours);

1. Schema technics and printed circuits
2. Study and achievements of small electronic modules
3. Practical Work: Microcontrollers

ELN 235: Maintenance of complex systems

Maintenance of complex systems : 4 credits (60 hours); L, T, P, SPW

1. Linear Servo
   - Concept of systems, functional schematics
   - Laplace transform and transfer functions
   - Analysis of the slave systems (response of a system to a given excitation: symbolic aspect and temporal, asymptotic plot of responses in the Plan de Bode)
   - Stability, Stability Criteria and diagrams
   - Correctors (P, PD, PI, PID): synthesis in the Plan de Bode

2. Installation and maintenance of complex systems:
   - Installation and maintenance of terminals
   - Installation and maintenance of systems of switched telephony
   - Specific Instrumentation: spectrum analyzers and networks, RF generators, mounted in instrumental Network (GPIB, Ethernet)
   - Specialized Instruments: testers of mobile and base stations, communication protocols, ...
   - Installation, configuration and maintenance of relay stations.
   - Techniques for the identification of the failures in the production and maintenance
   - Interconnection of networks (management and implementation of interconnect equipment: modem, routers and adapters various)
   - Systems of connections without wires (connection devices by infrared connection or electromagnetic waves).
   - Use of Test and Measurement equipment specializing

ELN 236: Data processing telecommunications networks

Telecommunication Networks : 2 Duration (30 hours); L, T, SPW

A- Telecommunications system

1. Reminder on the RF amplifications and on the notion of noise in electronics.
2. Coding and compression of the data
   - Coding of information;
   - Coding of source, channel coding;
   - Compression principle of sound;
3. **Production, dissemination and restitution of the image and the sound:**
   - Coding of sound (Processes NICAM, MUSICAM);
   - Organization of a radio dissemination system (analog, digital);
   - Image color video and encodings PAL, SECAM and digital video;
   - Organization of a system of TV broadcast (analog, digital);
   - Organization of a system of mobile telephony (DECT, GSM, GPRS, UMTS, etc.);

**B- Telecommunications networks**

1. **Reminders**
   - Concepts of data transmissions;
   - Physical media;
   - Protection against errors of transmissions:
     - Origins and Sources of errors:
       - Detection Mechanism;
       - Methods of correction.

2. **Construction of frames**
   - General Structures;
   - Synchronization mechanism;
   - Filling method;
   - Mechanism of acquittal.

3. **Model of access to networks (to the track)**
   - Access multiplexed: TMA, FDMA;
   - Centralized access;
   - Decentralized access;
   - Access to single frame.

4. **Models of networks**
   - Functional structuring in layers;
   - Protocols and services.

**Analogue and digital data processing and storage:** 3 Duration (45 hours); L, T, PW

1. Treatment of the analog signal in the areas audio and video frequencies (adaptation of impedance, modulation, amplification low levels and fort, filtering, production of signals, transposition of frequency, coupling of antennas …)
2. A/N and N/A conversions for audio and video
3. Compression, protection and treatment of the signal from the digital information (Multiplexing, Flow compression,…)
4. Standardized encodings both analog and digital
5. Specific engines, regulation of speed and position
6. Emission, spread and receipt of electromagnetic waves
7. Functional organization of transmission systems
8. Phase Lock Loops
9. Digital Spread Spectrum by Frequency Hopping Sequence and pseudo-random
10. Passive and active components of the radio frequency domain.

**ELN 237: Accounting and Labour Law**

- **Accounting**: 1 credits (15 hours); L, T
  1. General information on cost accounting and business management
     - Objective;
     - Role;
     - Concept of charge.
  2. Charge analysis
     - Embedded expenses;
     - Direct, indirect costs;
     - Valuation of stocks.
  3. Full cost method
     - Purchase cost;
     - Cost of production;
     - Cost price;
     - Calculation of results.

- **Labour Law**: 1 credit (15 hours); L, T

**A- First part**

1. The concept of Law;
2. The characters of the Law Rule;
3. Sources of Law (Hierarchical norms);
4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression).

**B- Second part**

1. Sources of Labour Law
2. The different employment contracts (classic contracts and precarious contracts)
3. Execution of the employment contract (salary and salary claim, various professional sanctions)
4. Dismissal and resignation;
5. Resolution of labor disputes
ELN 241: Mathematics IV

- Mathematics IV : 4 credits (60 hours); L, T, SPW
  1. One-dimensional descriptive statistics;
  2. Linear regression;
  3. Calculation of probabilities;
  4. Laws of probability;
  5. Sampling and
  6. Estimation method;
  7. Chi-square hypothesis test.

ELN 242: Computer Science II

- Computer Science II : 5 credits (75 hours); L, T, P, SPW
  1. Introduction
  2. Fundamental elements
     - Problem and algorithm;
     - Program and programming language;
     - From the problem to the computer solution;
     - The paradigms of programming;
  3. Concepts of programming in C++
     - Presentation and description of the programming language;
     - Structuring a program;
     - Descriptions of Data, Actions;
     - Programming style.

ELN 243: Computer Assisted Maintenance (CAM) of complex systems and Digital Servoing

- Maintenance of complex systems: 2 Duration (30 hours):
  1. Installation and maintenance of terminals
  2. Installation and maintenance of systems of switched telephony
  3. Specific Instrumentation: spectrum analyzers and networks, RF generators, mounted in instrumental Network (GPIB, Ethernet)
  4. Specialized Instruments: testers of mobile and base stations, communication protocols, ...
  5. Installation, configuration and maintenance of relay stations
  6. Techniques for the identification of the failures in the production and maintenance
  7. Interconnection of networks (management and implementation of interconnect equipment: modem, routers and adapters various)
8. Systems of connections without wires (connection devices by infrared or electromagnetic waves)
9. Use of Test and Measurement equipment specializing

- Basics of digital Servoing: 2 credits (30 hours);
  1. Review of Feedback Control fundamental
  2. Modeling of Digital Control Systems
  3. Analysis of Digital Control Systems
  4. Design of digital Controllers
  5. Case Studies

- ELN 244: Home Electronics: 4 credits (60 hours); L, T, P, PW

  - Home Electronics: 4 credits (60 hours); L, T, P, PW Audio technology
    1. Video technology and systems
    2. Applications.

- ELN 245: Practical work: Digital electronics and power control

  - Practical work: Digital electronics and power control: 4 credits (60 hours); P
    1. Programmable circuits and cards: 2 Duration (30 hours); P
    2. Power command and control circuits: 2 Duration (30 hours); P

- ELN 246: Professional internship

  - Professional internship: 6 credits (90 hours); P, PW
    1. Arrival and integration in the companies
    2. Work in a company
    3. Keeping the trainee journal
    4. Choice of the working theme in collaboration with the professional supervisor and the academic supervisor
    5. Development of the research framework
    6. Resources to exploit
    7. Organization of work
    8. Writing the report
    9. Presentation of the report before a jury

- ELN 247: Economy and business organization

  - Economy and business organization: 3 credits (45 hours); L, T, PW
    1. Concepts of General Economics
      - Introduction;
1. Consumption and production;
   • Income training;
   • Money and Credit;
   • Prices;
   • The notion of growth and development.

2. The Company
   • Introduction;
   • Typology of companies;
   • Structure and organization of the company;
   • Business and Ethics;
   • How to undertake (Create, Decide, and Manage).

3. The place of the company in the economic environment
   • Concept of the business environment;
   • Inter and extra-company relations;
   • Commercial activity;
   • Concept of Strategy.

4. Productive activity
   • Production policies and processes;
   • Trade policies;
   • Logistics.

5. The Concept of Management in the Company
   • Activity and financial resources;
   • Planning and management of human resources;
   • Planning and management of material resources.

6. Information and Communication in the Company
   • Role of information and communication;
   • Collection and organization of information;
   • Strategic diagnosis;
   • Decision system.
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<th>Field</th>
<th>ELECTRICAL AND ELECTRONIC ENGINEERING</th>
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<td>Specialty</td>
<td>ELECTROTECHNICS</td>
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1. **Objective of the training**

This specialty aims to train specialists in the study, implementation, use and maintenance of electrical equipment and electrical network. Electrical equipment, and thereby electrical network, are more and more sophisticated because of the evolution of computer and electronic technologies. These can today involve processes of hydraulics, pneumatics, optics, etc. It aims to provide students with technical knowledge and know-how that will enable them to take part in the design, construction and management of electro technical systems, mainly used in assembly lines or complex systems.

2. **Research Skills**

→ **Generic skills**

- Work independently and in team collaboration;
- Analyze, synthesize professional documents (French, English);
- Orally and writing communication (French, English);
- Participate in (other) lead project management process;
- Know and exploit professional and institutional networks of electricity sectors.

→ **Specific skills**

- Realize home and industrial electrical installation
- Operate power and current conversion;
- Understand and operate electronic modules for process control;
- Carry out maintenance and maintenance work on the processing and production lines
- Ensure home automation and fire safety
- Lead and realize a project in electricity

3. **Career opportunities**

- Technician in charge of study
- Construction technician in electrical installation
- Maintenance technician
- Electromechanical
- Test technician
- Head of after-sales services
4. Organization of the Teachings

- **FIRST SEMESTER**

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<td>Construction Design</td>
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</table>

**Fundamental Courses 30% (2 UC) 9 credits 135 hours**

**Professional courses 60% (4 UC) 18 credits 270 hours**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course titles</th>
<th>Number of hours</th>
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<td>ELT117</td>
<td>Bilingual Training</td>
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- **SECOND SEMESTER**

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<tr>
<td>ELT121</td>
<td>Mathematics II</td>
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<tr>
<td>ELT122</td>
<td>Physics and Computer Science</td>
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<tr>
<td>ELT123</td>
<td>Electrical Machines and Measurement Technics</td>
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<td>ELT124</td>
<td>Electronics and signal processing</td>
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<td>ELT125</td>
<td>Power Electronics</td>
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<tr>
<td>ELT126</td>
<td>CAD in Electrical Engineering</td>
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<tr>
<td>ELT127</td>
<td>Business creation, Civic and moral Education</td>
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- **THIRD SEMESTER**
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<tr>
<td>ELT231</td>
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<td>ELT232</td>
<td>Physics and Chemistry III</td>
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<td>ELT233</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<td>ELT237</td>
<td>Accounting and labour law</td>
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- **FOURTH SEMESTER**

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<td>ELT242</td>
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<td><strong>Fundamental Courses 30% (2 UC)</strong> 9 credits 135 hours</td>
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<tr>
<td>ELT243</td>
<td>Maintenance and industrial Networks</td>
<td>30</td>
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<tr>
<td>ELT244</td>
<td>Electrical Installation and Equipments</td>
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<td>ELT245</td>
<td>Practical Work Electrical Machine II</td>
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<td>ELT246</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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</tr>
<tr>
<td>ELT247</td>
<td>Economy and business organization</td>
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<td>15</td>
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<td>175</td>
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5. Course content

❖ ELT 111: Mathematics I

➢ Mathematics : 4 credits (60 hours); L, T, SPW
  1. Functions of a real variable.
  2. Circular, hyperbolic, and reciprocal functions.
  5. Taylor Formula and limited developments.
  7. Multiple integrals and their applications to the calculation of area and volume.

❖ ELT 112: Physics and Chemistry: 4 credits (60 hours);

➢ Physics : 3 credits (45 hours); L, T, P, SPW
  1. Kinematics
     ▪ Introduction;
     ▪ Referential system and position vector;
     ▪ Speed and acceleration;
     ▪ Movement in the field of gravity.
  2. Action of forces on a material point
     ▪ Principle of inertia and fundamental principle of the dynamic;
     ▪ The superposition of Forces;
     ▪ The forces of inertia;
     ▪ Friction and friction forces.
  3. Gravitation
     ▪ The force of gravitation;
     ▪ Law of gravitation;
     ▪ Fields of forces.
  4. Work, Power, Energy and Momentum
     ▪ Work;
     ▪ Power;
     ▪ Energy;
     ▪ Momentum.
  5. Action of the forces on a solid body
     ▪ Static;
     ▪ Kinetics of solid bodies.
  6. Fluid Mechanics
     ▪ Fluid and gas at rest;
     ▪ Incompressible liquid.
Chemistry : 2 credits (30 hours); L, T, P, SPW

1. **Nuclear Reactions**
   - Describe the structure of a nucleus (Mass number, atomic number).
   - Characterization of isotopes;
   - Distinguish the different reactivity (spontaneous and non-spontaneous reaction);
   - Establish the equation of a radioactive transformation;
   - Assess the fault of mass and the energy released by a nuclear reaction;
   - Half-life of the radioactive decay;
   - Activity of radioactive isotopes;
   - Radiation protection;
   - Experimental strategy to quantify the radiation received in function of time, distance and materials crossed.

2. **Pure body and mixtures**
   - Distinguish between the different types of mixtures (suspensions, emulsions, alloys, aqueous solutions, smoke and fog);
   - Solubility of a solute in a solvent. Homogenous and heterogeneous Solutions;
   - Density of a solution, Molar concentration, Mass concentration, the molarity, molar fractions and mass concentrations.
   - Distinguish between the molar concentration of the normality;
   - Establish and apply the relations between sizes and molar mass quantities;
   - Describe and explain the operation of a process of liquid-liquid extraction;
   - Establish a balance sheet of overall material and partial to each of the constituents of a liquid-liquid extraction;
   - Articulate and apply the law of perfect gases;
   - Define the total pressure and partial pressures for a gaseous mixture;
   - Difference between absolute and relative pressure;
   - Establish the expression and evaluate the density of a real and a perfect gas;
   - Describe and explain the process of extraction liquid-gas: absorption and desorption;
   - Establish a balance sheet of overall material and partial to each of the components of an extraction liquid-gas.

3. **Chemical reactions**
   - Electronic structure of an atom;
   - Bonding (ionic and covalent bonds);
   - Molecular model of Lewis;
   - Establish an equation of reaction;
   - Establish a molar balance sheet;
   - Standard enthalpy of reaction;
   - Exothermic and endothermic reactions;
4. **Speed of chemical reaction**
   - Set the speed of a reaction by report to a reagent or product;
   - Define the constant speed;
   - Set the order of a reaction by report to a reagent and exploit the equation giving its concentration as a function of time;
   - Define the Time of half-reaction;
   - Identify the factors kinetics: influence of temperature and concentration from follow-up data on the reaction;
   - Explain the role of a catalyst;
   - Operate the curve giving the evolution of a composition of a reagent or a product in the time to identify the order of reaction and evaluate the speed constant and the time to half-reaction.

5. **Reaction in aqueous solution; Acidic, basic and oxido-reduction**
   - Define the specific vocabulary: acid, base according Brönsted, oxidizing, reducer;
   - Oxidation, reduction, torque acido-basic, redox couple;
   - Acido-basic reaction; redox highlighting: exchanges of protons and then of electrons;
   - Establish a link between the powers dissociating, dispersant and solvating of water and its physical properties and molecular structure;
   - Explain the particular case of the water: couples in the water, autoprotolyse, Ke, ampholyte;
   - The reactions acido-basic;
   - Redox reactions.

6. **Organic chemistry**
   - Identify the gross formulas, developed planes, semi-developed topological and isomers of Simple hydrocarbons (alkanes, Cyclanes, alkenes, benzene) and their derivatives (alcohol, carboxylic acid, aldehydes and ketones) and know the appoint;
   - Establish a link between the structure of a molecule of hydrocarbon and its chemical properties;
   - Distinguish between the three types of reactions in organic chemistry: substitution reactions, addition and elimination;
   - Distinguish monomer and polymer;
   - To distinguish the types of reactions of polymerization;
   - Describe the properties of a few industrial polymers.

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**ELT 113: Basics of Electricity and Electrical Circuits**

- **Basics of Electricity and Electrical Circuits 5 credits (75 h); L, T, PW**
  1. **Mathematical tools**
     - Elements of vector calculation (coordinate systems, scalar and product, vector product);
     - Scalar Field, Vector Field, and Field Vector Flow.
2. **Electrostatic field and potential**
   - Electrostatic field;
   - Electrostatic potential;
   - Work of an electrostatic force;
   - Distribution of electrical charges;
   - Electric dipole;
   - Electrostatic field flux - Gauss theorem.

3. **Magnetic induction - Ampère theorem**
   - Lorentz force and magnetic induction (Lorentz force, motion of a charged particle in an uniform electric field and in a uniform magnetic field);
   - Magnetic effects of the currents (Laplace and BIOTSAVART Law, Notion of current density);
   - Magnetic flux induction, Ampère theorem;
   - Magnetic induction created by a circular conductor at a distant point, Magnetic moment concept.

4. **Work of electromagnetic forces**
   - Movement of a circuit in a magnetic field;
   - Notion of inductance (self-inductance, mutual-inductance);
   - Applications.

5. **Electromagnetic induction**
   - Displacement of a conductor in a uniform magnetic induction (Electromagnetic field and induced emf, LENZ law, Notion of generator and motor);
   - FARADAY’S induction law (Self-induction, EMF of self-induction, Establishment and extinction of a current in a RL-circuit);
   - Magnetic energy;
   - Applications.

6. **Capacitances-capacitors**
   - Capacitance of an isolated capacitor (Definition, Capacitance of a conducting sphere);
   - Capacitor (Definition, Load carried by the armatures: case of a spherical capacitor to simplify);
   - Grouping of capacitors;
   - Charging and discharging a capacitor through a resistor.

7. **Single phase alternating current**
   - Reminders on complex numbers;
   - Sinusoidal voltages and currents;
   - Ohm’s Law in A C;
   - Dipole in AC;
   - Power in AC systems single phase;
   - Power balance in a circuit - Boucherot’s theorem.

8. **Three-phase sources**
   - Balanced sources: sinusoidal voltages and currents;
   - Balanced three-phase loads;
   - Unbalanced loads;
- Three-phase AC power

**Electrical circuits : 2 credits (30 hours):L, T, SPW**

1. **Direct current electrical circuit:**
   - Electric dipole: definition, current and voltage as oriented quantities, linear dipole, nonlinear dipole, active and passive dipole, static characteristic, convention of the senses and energetic behavior, linear resistance and Ohm's law, nonlinear resistance;
   - Methods of analysis of DC linear circuits: Kirchhoff’s laws, Helmholtz’s theorem, mesh currents method, Millman's theorem;
   - Interaction between an active dipole and a variable passive dipole: voltage, current intensity, power, internal losses, efficiency, power adaptation;
   - Simplification of linear circuits: passive linear circuits (equivalence theorems, Kennely's law), active linear circuits (Thévenin's theorem, Norton's theorem).

2. **Periodic phenomena**
   - Periodic electrical quantities: period, frequency, continuous value, rms value, active power, oscillation, characteristic ratios of periodic quantities;
   - Sinusoidal electrical oscillations: characteristics (amplitude, pulsation, phase at the origin), average values, superposition, representations (Fresnel vector, complex symbol);
   - Non-sinusoidal electrical oscillations: Fourier series of a non-sinusoidal oscillation, Specific definitions of the non-sinusoidal electrical regime (rms value, active power, apparent power, power factor, reactive power, distortion power, harmonic rate, ripple, etc.), Response of a linear circuit to a non-sinusoidal excitation.

3. **Linear electric circuit in fixed frequency sinusoidal mode:**
   - Notion of linearity of electric dipoles in sinusoidal excitation;
   - Modeling passive linear elementary dipoles: Ohm's laws, electrical dipole behaviors in sinusoidal excitation;
   - Linear diodes in sinusoidal mode: instantaneous power, active power, apparent power, reactive power, power factor, complex power;
   - Linear circuits in sinusoidal regime: Kirchhoff laws, association of passive elementary dipoles, simplification of passive linear circuits (laws of division of voltage and current, Kerrely's law), resonance, simplification of active linear circuits (power of the source, Thévenin's theorem, Norton's theorem), power adaptation, compensation, analysis methods (Kirchhoff's laws, Helmholtz's theorem, mesh currents method, Millman's theorem);
   - Electrical quadrupole concept: parameters, input and output impedances, wave resistance and apparent power matching, image impedances.
4. **Linear electrical circuit and sinusoidal excitation with variable frequency:**
   - Expression of parameters as a function of frequency;
   - Response of a linear circuit to sinusoidal excitation when the frequency varies;
   - Parameter locations and their inversion, transfer function, amplification or gain;
   - Diagram of Bode and Nyquist;
   - Classic filters.

5. **Establishment and interruption of the electric current in a linear circuit:**
   - Switching of a linear circuit (RL, RC, RLC) subjected to a constant voltage;
   - Switching of a linear circuit (RL, RC, RLC) subjected to a sinusoidal voltage.

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**ELT 114: Electrical machines I**

- **Electrical machines I: 5 credits (75 h); L, T, SPW**

A- **DC machines**
   1. Magnetic circuit
   2. Constitution and operating principle
   3. Modeling and characteristics (construction of Picou ...)
   4. Energy balance
   5. Reversibility of DC machines
   6. Operating as Generators of different types of dc machine
   7. Operating as Motors operation of different types of dc machine
   8. Scope, selection and maintenance of DC machines

B- **Transformers**
   1. **Single phase transformers**
      - Constitution and operating principle;
      - Design and diagrams;
      - Characteristics and tests;
      - Energy balance;
      - Operating conditions of machines connected in parallel.
   2. **Three-phase transformers**
      - Constitution and operating principle;
      - Connection of windings, inflation of windings;
      - Phase displacement, characteristic and tests.
   3. **Special transformers (for measuring)**
      - Self-transformer;
      - Voltage transformer;
      - Current transformer.
   4. **Choice of Transformers and Maintenance**
ELT 115: Electronics and Automatism

A- Preliminary considerations and essential relating to industrial automation

1. Introduction
   - Definition and Concept;
   - Functions and objectives;
   - Requirement and complexity.
2. The bases of the Boolean algebra
3. Method of analysis
   - Method of chronograms;
   - Method of Karnaugh.
4. Method of Synthesis
   - Synthesis by wired technology;
   - Grafcet Method (Analysis Grafcet);
   - Synthesis and Technologies.

B- Essential considerations relating to Industrial Automation with programmable technology

1. Definition and Concepts
2. Technology of industrial automation, criteria of choice
3. Industrial Automation API
   - The programmable automation industrial;
   - Hardware and functional organization;
   - Interfacing and extension;
   - Choice of appropriate Automation.
4. Study of an appropriate Automation (according to availability)
   - Architecture and environment;
   - Programming language;
   - Implementation and choice.
5. Practical work in laboratory

Electronics I : 2 credits (30 hours); L, T, SPW

6. Basical notions of semi-conductors
7. The Diodes
   - Current-Voltage characteristics of the an ideal diode;
   - Current-Voltage characteristics of a real diode;
   - Operating limits;
   - A few special diodes;
   - Notions of operating-point;
   - Applications of diodes.
8. Bipolar Transistor
   - Introduction;
   - Structure and operation;
• Characteristics of an NPN;
• Operating Limits;
• Notions of operating-point;
• Dynamic model.

9. Field Effect Transistor (FET)
• Introduction;
• Current-Voltage characteristics;
• Different Types of FET;
• A few circuits of polarization;
• Applications of FET.

❖ ELT 116: Construction Design

➢ Construction Design: 3 credits (45 hours) L, T, SPW
1. Generalities:
   • Generalities on drawing;
   • Dimensional dimensioning of a drawing
   • Connections.
2. Perspective
   • Perspective projection of a drawing;
   • Axonometric perspectives.
3. Projections
   • Plan reading.
4. Cuts and sections
   • Different kinds of cuts;
   • Different kinds of sections;
   • Overall drawing;
   • Drawing for definition
5. Mechanical connections
   • Connectors (threaded and unthreaded);
   • Types of links;
   • Characteristics of a link.
6. Adjustments
   • Tolerance ratings;
   • Adjustments.
7. The guides
   • Translation guidance;
   • Rotational guidance;
   • Blocking concept;
   • Concept of lubrication.
ELT 117: Bilingual training

- **English**: 1.5 credits (22 hours 30mn)); L, T, SPW
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication
  4. **Autonomous reading of "writings" of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
     - C.V;
     - Letter of motivation;
     - Letter/memo writing and minutes of a meeting

- **French**: 1.5 credits (22 hours 30mn)); L, T, SPW
  1. **Vocabulaire**
     - Vocabulaire technique usuel
  2. **Grammaire**
     - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
     - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
     - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
     - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
     - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
     - Des fonctions grammaticales.
  3. **Expression et communication**
     - Compréhension et interaction au cours d’une discussion technique :
     - Communication orale courante ;
     - Communication orale interactive ;
     - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
Lecture rapide et compréhension de texte ;
Synthèse de texte
De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
Expressions figées

ELT 121: Mathematics II

Mathematics II : 4 credits (60 hours); L, T, SPW
1. Numerical Sequences
2. Numerical Series
3. Fourier Series
4. Laplace transformation
5. Fourier transformation
6. Multi-variable functions- Scalar and vectors fields and their applications

ELT 122: Physics and Computer Science

Physics II : 2 credits (30 hours); L, T, P, SPW
A. Oscillations and Waves
1. Kinematics of oscillating bodies
   - Generalities ;
   - The harmonic oscillator;
   - Superposition of oscillations.
2. Dynamics of oscillating bodies
   - Free and damped oscillations
   - Forced and coupled oscillations.
3. Waves
   - Generalities ;
   - Harmonic waves; Groups of waves; Energy transport;
   - The superposition of waves;
   - Reflection, refraction and diffraction of waves;
   - Sound waves and ultrasound.

Computer Science I : 3 credits (45 hours); L, T, P, SPW
1. Generalities and vocabulary
   - Concept of information and informatics;
   - Resolution of problems by the informatics;
• Typology and computer configuration;
• Fields of application of informatics;

2. **Information representation and processing**
   • Systems of numbers;
   • Representation of Numbers and Characters (coding of information);
   • Boolean logic;
   • Circuits of calculations & memory;
   • Presentation and differences between numerical & non-numerical data.

3. **Structure and operation of a micro-computer**
   • Architectures of a micro-computers;
   • Functional units (Central Unit, Units of entry and exit);
   • Architecture and performance of microprocessors;
   • Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
   • Presentation and roles of programs; their applications.

4. **A Computer : An Interface “Machine (Hardware) - Man (Software)” as solutions to problems**
   • The bios;
   • The systems of applications;
   • Application programs.

5. **Operating systems and examples of operating system**
   • WINDOWS (DOS);
   • Linux: an interesting alternative ;

6. **A few examples of applications software**
   • The "Package Microsoft Office" (Word, PowerPoint, Excel);
   • The software of navigation and search engines on the Web.

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**ELT 123: Technics of Measurement and Electronics**

➢ **Measurement techniques: 2 credits (30 hours)**
   1. **Chains measurement**
   2. **Sensors**
      • Principles of operation;
      • Choice of the principle and choice of the appropriate sensor;
      • Absolute, relative, differential sensors;
      • Range of measurement and sensitivity;
      • Dynamics sensor.
   3. **Power electronics**
      • Current and voltage supply;
      • Charge amplifier;
      • Sensitivity.
   4. **Signal processing concept (in the data acquisition context)**
      • Different types of signals;
      • Sampling;
- The fall in the spectrum;
- Digitization;
- Fourier analysis;
- Estimate of the DSP;
- Filtering.

5. **Measurement uncertainties**
- Reminders of probabilities notions;
- Mean, standard deviation, measurement duration;
- Compositions of errors;
- Distribution function;
- Density of probability;
- Normal and student distribution;
- Robust estimators;
- Histograms.

6. **Modeling of Measurements**
- Correlation between two random variables;
- Regression of first and second art;
- Model of the least squares method;
- Chi-square method;
- Periodic effects;
- Questionable measures;
- Validation of the model;
- Quality of the adjustment.

7. **Reference quantities and calibrations**
- Reference quantities and transfer standard (for mechanical quantities);
- Calibration and digital acquisition.

8. **Counting in digital acquisition**
- Signals and encoders;
- Tachymetric signals;
- Proximity sensors;
- Tachymetric sensors;
- Real time;
- Internal clock.

- **Electronics II and Practical Works: 3 credits (45 hours):**

  1. **Diodes**
     - Representation of the Current-voltage characteristics;
     - Half wave rectification;
     - Current-voltage characteristics of the Zener diode;
     - Stabilization of the voltage with the Zener diode.

  2. **Transistors**
     - Transistor characteristics and network;
     - Basic circuits of transistor amplifier;
     - Signal generating with RC-circuits;
Memory circuits (flip-flops);
RS, D, JK flip-flops.

3. Thyristors
   - Influence of the trigger voltage on the current;
   - Use of thyristor as DC-voltage switch.

4. Operational amplifiers
   - Basic circuits with operational amplifiers;
   - Coding circuits;
   - 8421-BCD converter / Exess 3;
   - 8421-BCD decoder / 7 segments.

**ELT 124: Electronics and Signal Processing**

- **Electronics II: 3 credits (45 hours); L, T, PW**
  1. **Amplifier based on transistors**
     - Characteristics of an amplifier;
     - Ideal amplifier;
     - Fundamentals Circuits.
  2. **Linear electronic with operational amplifier**
     - The ideal Operational Amplifier;
     - Basics Circuits;
     - Active filters;
     - Sinusoidal oscillators.
  3. **Combinatory Logic**
     - The binary system;
     - Transcoding;
     - Definition of the switching algebra;
     - Study of a few logical functions;
     - Modes of representation of logical functions;
     - Simplification of logical functions.
  4. **Introduction to the sequential logic**
     - Memory circuits (flip-flops);
     - Analysis and synthesis of counters.

- **Signal Processing: 2 credits (30 hours); L, T**
  1. **Definition and classification of signals**
     - Continuous and discrete signals;
     - Periodic signals;
     - Simple transformations of signals and their visualization.
  2. **Sampling and quantification of signals**
     - Quantification of signals;
     - Sampling of signals;
     - Criterion of Shannon-Nyquist;
     - Power of Signals.
3. **Fourier transform**
   - Definitions;
   - Periodic signals and time limited signals;
   - Fourier series and its properties;
   - Fourier transform and its properties;

4. **Transfer function**
   - Definitions and properties of the transforms of Laplace;
   - Analog Filter, causality and transfer function;
   - Criterion of stability of analog filters;
   - Analogic Filter with minimum and linear phase.

5. **Introduction to filtering**
   - Definition;
   - Impulse response;
   - Relationship input-output, discrete convolution;
   - Frequency response;
   - Transformed into Z.

6. **Modeling of signals and numerical systems**

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**ELT 125: Power electronics and actuator control**

- Power electronics and actuator control: 4 credits (60 hours) L, T, SPW

**A. Power electronics**

1. **Introduction**
   - General considerations;
   - Definition and objectives;
   - Different types of power conversion.

2. **AC / DC converter**
   - Voltage rectifiers (with diodes, single and three-phase thyristors), internal operation;
   - Definition and measurement of input-output quantities;
   - Reversibility.

3. **DC / DC converters**
   - Power transistors switching;
   - Study of basic choppers (direct link chopper, chopper, reversible chopper);
   - Isolated switching power supplies;
   - Symmetrical power supplies.

4. **DC / AC converters**
   - Full wave voltage inverters (single-phase, three-phase);
   - UPS in PWM: Principles;
   - Uninterruptible power supply structures;
   - Technologies of storage batteries.

5. **AC / AC converters**
   - Triacs technology;
Study of dimmers;
Study of cyclo-converters.

6. **Thyristor and Triacs triggering device and circuit**
   - DC and AC priming;
   - Pulse priming.

7. **Electronic controls of machines**
   - Variable speed drive for DC machines;
   - Variable speed drive for AC machines.

**B. Actuator control**

- **ELT 126: CAD in Electrical Engineering**
  - **CAD in Electrical Engineering**: 4 credits (60 hours) L, T, SPW
    1. Choice of CAD-Software (s) and practical Information
    2. Presentation and description of the Software (s)
    3. Management of created Data
    4. Study and handling of different modules
    5. Applications to realization of a mini-projects

- **ELT 127: Business Creation and Civic and Ethical Education**
  - **Entrepreneurship**: 1 credit (15 hours) ; L, T, SPW
    1. Entrepreneur concept
    2. Motivations for starting a business
    3. Ideas research and evaluation
    4. Financing research
    5. Choice of legal status

  - **Civic and moral education**: 2 credits (30 hours); L, T

  **The Concepts**
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem ;
  - Ethics and management.
  - Civics
  - Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics

**ELT 231: Mathematics III**

- Mathematics III : 4 credits (60 hours); L, T, SPW
  1. Linear systems
  2. Complex numbers
  3. Polynomials functions and rational fractions
  4. Vector spaces and Euclidean vector spaces
  5. Linear applications
  6. Matrices

**ELT 232: Physics and chemistry III**

- Physics III : 3 credits (45 hours); L, T, P,SPW
  1. Thermodynamics
     - Temperature and thermal expansion;
     - Heat and fundamental principle of thermodynamics;
     - Change of state of the ideal gases;
     - Kinetic theory of heat;
     - Cyclical process: 2nd fundamental principle of thermodynamics;
     - Change of state;
     - Propagation of heat.
  2. Electrodynamics and applications
     - Currents and fields;
     - Production of magnetic fields;
     - Induction phenomenon;
     - Alternating current;
     - Electromagnetic waves.

- Chemistry: Basics of Quality, Health, Safety and Environment 2 credits (30 h; L, T, P, SPW)
  1. Management system of a company
     - Identify the management system of a company using the global standards ISO 9001 and 14001;
     - Use and master the vocabulary of management systems.
  2. Fight against nonconformities and loop of continuous improvement.
- Use and master the vocabulary of continuous improvement;
- Identify the implementation of the continuous improvement loop, regardless of the domain or company involved: ascertain, isolate / contain, analyze causes, treat causes, measure effectiveness;
- Identify nonconformities, their degree of severity and their consequences in any context;
- Propose corrective and preventive actions, even improvement, within the limits of its field of intervention;
- Respect the rules of traceability within the limits of its field of intervention.

3. **Risk analysis and prevention.**
   - Participate in a risk prevention analysis;
   - Participate in a dynamic risk impact analysis;
   - Implement a prevention plan or emergency plan in its area of intervention.

4. **Regulations and technical standards.**
   - Situate its action within the framework of the operational technical standards developed by the IEC TC 65: for example the IEC 61508, IEC 61326, IEC 62443, IEC 62424, IEC 62708 series, etc.
   - Recognize the pictograms, hazard classes and precautionary and prevention statements of the CLP Regulation;
   - Apply the rules of prevention, limitation or prohibition related to the REACH Regulation on substances and their uses, whether in the form of raw materials, in mixtures, or contained in "articles";
   - Apply ATEX regulations related to the control of risks related to explosive atmospheres;
   - Comply with the sorting instructions for end-of-life CIRA equipment, issued by the Waste Electrical and Electronic Equipment (WEEE) Directive.

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**ELT 233: Energy production and Schema**

- **Electrical Schema and command: 2.5 credits (40 hours)**

  1. **Classification of wiringschema**
     - Definitions;
     - Explanatory, functional and architectural schema;
     - Schema of achievement;
     - Modes of representation.

  2. **Marking and identification of the Elements**
     - Identification mark;
     - Marking of end points (simple elements, appliances, main contacts, auxiliary contacts, organs of control);
     - Cables identification (dependent and independent identification, colors identification);

  3. **General rules for the execution of schemas**
- Graphical symbols for electrical schemas, tracking in developed schema, crossing of conductors, examples of circuit diagrams.

4. The power control
   - Control pannel;
   - Sectioning;
   - Protections (short circuit, overload);
   - Electromagnetic contactor;
   - Device association and coordination;
   - Starters and drives of Electronic Speed (types, functions, mode of operation).

5. Basics Schemas
   - Contactor and basics wiring schemas;
   - Control of one contactor, two contactors;
   - Control circuit power;
   - Signaling of protective devices;
   - Starting of engines to cage, with bushings;
   - Power supply by electronic starter, by electronic variator.

6. Home and industrial electrical installations BT
   - Drivers/pipes and choice;
   - Determination of the optimal power facility;
   - Coefficient of use and coefficient of simultaneity;
   - Power of the power supply transformer MT/BT;
   - Compensation of reactive energy;
   - Case study.

7. The neutral Schemes
   - The SLT: TT, IT, TN, and protection against electric shock.

➤ Technique of production, transport and distribution: 2.5 credits (35 hours);

A- Production
   1. Basic concepts
      - Primary sources of energy;
      - Secondary sources of energy;
      - Chain of transformation.
   2. Central of energy production
      - Hydraulic , thermal (fuel, gas), nuclear.
   3. Renewable energies
      - Solar (radiation, photovoltaic);
      - Wind turbine;
      - Biomass, cogeneration, Other.

B- Transport and Distribution
   1. Reminders
      - Regulatory, Standards, Recommendations, areas of tension.
   2. Post of transformation
      - Characteristics of transformers.
3. **Lines and brackets of transportation**
   - Cables and pipes;
   - Transport and distribution Networks;
   - Signage and tracking, HT positions;
   - Electrical equipment used in high voltage;
   - Work and interventions on equipment in areas with BT, TBT and HT circuits;
   - Operations on Off-circuit;
   - Operations at the neighborhood on the HTA.

4. **Basics Apparatus (simple and combined)**
   - Functions of the apparatus of basis (protection, sectioning, command);
   - Personal Protective Equipment (PPE);
   - Instructions and written documents.

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**ELT 234: Servoing and Data communication**

- **Servoing:** 3 credits (45 hours);

1. **General Considerations and essential relating to servoing systems**
   - Definitions and Structures;
   - Classification (linear servoingsystems, non-linear servoing systems, sampled systems).

2. **Analysis of linear servoing Systems**
   - Definitions and specific considerations; Modeling:
     - Mathematical tools (symbolic calculations);
     - Transfer Function (transmittances) and algebra graphs;
     - Graphical representation (Bode, Nyquinst and black and Nichols);
     - Application (electrical systems, mechanical...).

3. **Characterization of linear servoingsystems Linear**
   - Stability:
     - Algebraic criteria;
     - Simplified criteria (Bode);
     - Criterion of Nyquinst and Routh.
   - Accuracy:
     - Harmonic regime;
     - Regime Established.

4. **Correctors on linear servoing systems Linear**
   - Correctors in cascade : P, PI, PD, and PID, in advance of the PHASE AP, to delay of RP phase and to advance-delay of ARP phase;
   - Correctors by chain of secondary reaction.

- **Data Communication:** 2 credits (30 hours); L, T

1. The parallel inputs/outputs
- Programmable circuits;
- Study of a PIA (Parallel Interface Adaptor);
- The Inputs/Outputs polling by; masks.

2. **Asynchronousseries Interfaces**

3. **Conversion N/A and N/A**
   - Conversion N/A;
   - Conversion A/N;
   - Piloting of a map of CAN/NAC.

4. **Parallel Interface timer (PIT)**

5. **Presentation and application of a microcontroller**

6. **Communication of data and local networks**
   - The requireprotocols;
   - The TCP/IP model;
   - The ISO model;
   - Topology of the local networks.

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**ELT 235: Electronics III + TP**

- **Electronics III + TP: 4 credits (60 hours); L, T, SPW**

  1. **The Diodes**
     - Representation of the current-voltage characteristics;
     - Simple alternatelyRecovery;
     - Current-Voltage characteristics of the Zener diode;
     - Stabilization of the tension with the Zener diode.

  2. **The transistors**
     - Networks of characteristics of the transistors;
     - Basics circuit of Amplifiers with transistors;
     - Signal generation with RC-circuits;
     - Memory elements (scales); RS-Type Latches, D, JK.

  3. **The thyristors**
     - Influence of the trigger voltage on the current;
     - Use of the thyristor as switch in continuous voltage.

  4. **The operationalamplifiers**
     - Basics circuit of operational amplifiers;
     - Coding circuits;
     - 8421 converter-BCD / Excess 3; 8421 decoder-BCD / 7 segments.

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**ELT 236: Practical Work Automation and Logic and Advanced Electronics**

- **Advanced Electronics : 2 credits (30 hours); L, T,SPW**

  **A-Analog electronics**

  1. **Study of the differential pair**
     - Operating conditions at equilibrium and out of equilibrium;
2. **Linear and non-linear electronics with OP Amplifier**
   - Basic assemblies: inverter, integrator, negative resistance simulation;
   - Comparators: adjustable phase, zero threshold, hysteresis (schmitt trigger);
   - Multivibrators.

3. **Oscillators (relaxation, direct component, integrated circuit)**
   - The switching transistor and its implications;
   - Generation of triangular and square signals with timers.

4. **Study of particular electronic functions**
   - Regulated power supplies;
     - Recovery and filtering by capacitor;
     - Principles of regulations (series and parallel);
     - Zener diode and transistor regulation, use of a ballast;
     - Protection of power supplies;
     - Principle of switching power supplies;
   - A / D and D / A conversions:
     - Study of some specific circuits, especially in flash conversion.
   - Nonlinear amplification:
     - The push-pull class B and C;
     - Principle of the class D amplifier.
   - The phase locked loop (PLL):
     - The circuits of the VCO, the phase comparator;
     - Qualitative and quantitative study of the PLL loop: equation and gripping conditions.

➢ **Practical Work: Automation and Logic**: 2 credits (30 hours);

sword green ➢ **ELT 237: Accounting and Labour Law**

sword green ➢ **Accounting**: 1 credits (15 hours): L, T

1. **General information on cost accounting and business management**
   - Objective;
   - Role;
   - Concept of charge.

2. **Charge analysis**
   - Embedded expenses;
   - Direct, indirect costs;
   - Valuation of stocks.

3. **Full cost method**
   - Purchase cost;
   - Cost of production;
   - Cost price;
   - Calculation of results.
- Labour Law: 1 credit (15 hours); L, T

A- First part

1. The concept of Law;
2. The characters of the Law Rule;
3. Sources of Law (Hierarchical norms);
4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression).

B- Second part

1. Sources of Labour Law
2. The different employment contracts (classic contracts and precarious contracts)
3. Execution of the employment contract (salary and salary claim, various professional sanctions)
4. Dismissal and resignation;
5. Resolution of labor disputes

- ELT 241: Mathematics IV

- Mathematics IV : 4 credits (60 hours); L, T, SPW

1. One-dimensional descriptive statistics;
2. Linear regression;
3. Calculation of probabilities;
4. Laws of probability;
5. Sampling and
6. Estimation method;
7. Chi-square hypothesis test.

- ELT 242: Computer Science II

- Computer Science II : 5 credits (75 hours); L, T, P, SPW

1. Introduction
2. Fundamental elements
   - Problem and algorithm;
   - Program and programming language;
   - From the problem to the computer solution;
   - The paradigms of programming;
3. Concepts of programming in C++
- Presentation and description of the programming language;
- Structuring a program;
- Descriptions of Data, Actions;
- Programming style.

❖ ELT 243: Maintenance and industrial networks

➢ Maintenance in electrical Engineering : 2 credits (30 hours);

   1. Definition of maintenance ;
   2. Different types of maintenance ;
   3. Definitions of maintenance operations ;
   4. Maintenance levels ;
   5. Maintenance management;
   6. Approach of maintenance;

➢ Industrial networks: 3 credits (45 hours); L, T, SPW

1. Corporate LAN
   - Internet network : Functionality, architecture, wiring, operation, analogy to the OSI model;
   - Industrial applications.

2. Field networks
   - Industrial context;
   - Distribution unto decentralization of industrial applications;
   - Models of communication: Client - Server; Producer - consumer;
   - Network of sensors / actuators : specificities, study protocols, analogy to the OSI model, standardization, cases of applications (ASI, I2C, FIP-io, van, CAN, PROFIBUS-PA, ...);
   - Networks of automatism: specificities, study protocols, analogy to the OSI model, standardization, case of applications (Profibus, Interbus-S, Modbus, DEVICE NET, MODLINK, ...);
   - Networks in building automation...: specificities, study protocols, analogy to the OSI model, standardization, case of applications (Batibus, IBE, EHS, Lonworks, ...); international standardization.

3. Interconnection of networks
   - Elements of interconnection:
     - Physical segmentation (repeater, bridge, hub, switch);
     - Logical segmentation (Router, Gateway).
   - Mechanisms and Routing Protocols and of interconnection: Source Routing, Spanning Tree, RIP, EGP;
   - The protocols TCP/IP: IP Addressing, Transport protocols TCP (role and structure of the frames), protocols, IP networks (the role and structure of the frames), Protocols of resolutions to address (ARP, RARP), a control protocol (ICMP).

4. Perspective and Evolution of the industrial communication.
   - Supervision and conduct (see Remote Control of industrial processes).
ELT 244: Electrical installations and apparatus

- Electrical installations and apparatus: 5 credits (75 hours); L, T, SPW

1. General information on the electrical equipment in current use
   - Characteristics: Voltage, intensity;
   - Powerbreaking;
   - Functions: sectioning, cut, control, protection.

2. Use of electrical appliances in current use
   - Disconnect Switch, Switch / Circuit Breaker / switch, overcurrent release;
   - The fuses (characteristics) / The thermal relay / differential protection;
   - indices of protection (IP); Use of measuring devices;
   - The pathophysiological effects of the current on the human body.

3. Prevention - Compliance with the standards and safety instructions
   - Legal framework and administrative regulations, applicable standards;
   - Safety requirements for construction, operation and maintenance;
   - Facilities: classes of voltage and different indices.

4. Some important definitions
   - Distances of approaches;
   - Work under voltage (approach of consequences);
   - Instructions and responsibilities.

5. The protection of persons against direct and indirect contact
   - Definition, various means of protection;
   - Different patterns of binding of earthing, (diagrams TT, IT, TN);
   - Contact Voltage, cut-off time, resistance of the masses, the resistance of the neutral;
   - Contact from the earth, the equipotential bonding;
   - Differential circuit breaker, Principle of operation;
   - Protection against direct contacts: differential devices at high sensitivity;
   - Use of the means of individual protection;
   - Double insulation, circuits of separation, use of the very low voltage;
   - Choice and connections of the electric power tools on the basis of the place of work and the characteristics of the installation;
   - Protection against overcurrent: fuses, thermal magneto-thermical circuit breakers

ELT 245: Practical Work: Electrical Machines II

- Practical Work: Electrical Machines II: 4 credits (60 hours); P

1. Alternators;
2. Coupling of alternators to the electrical network;
3. Synchronous motors;
ELT 246: Professional internship

- Professional internship: 6 credits (90 hours); P, SPW
  1. Arrival and integration in the companies
  2. Work in a company
  3. Keeping the trainee journal
  4. Choice of the working theme in collaboration with the professional supervisor and the academic supervisor
  5. Development of the research framework
  6. Resources to exploit
  7. Organization of work
  8. Writing the report
  9. Presentation of the report before a jury

ELT 247: Economy and business organization

- Economy and business organization: 3 credits (45 hours); L, T, SPW
  1. Concepts of General Economics
     - Introduction;
     - Consumption and production;
     - Income training;
     - Money and Credit;
     - Prices;
     - The notion of growth and development.
  2. The Company
     - Introduction;
     - Typology of companies;
     - Structure and organization of the company;
     - Business and Ethics;
     - How to undertake (Create, Decide, and Manage).
  3. The place of the company in the economic environment
     - Concept of the business environment;
     - Inter and extra-company relations;
     - Commercial activity;
     - Concept of Strategy.
  4. Productive activity
     - Production policies and processes;
     - Trade policies;
     - Logistics.
  5. The Concept of Management in the Company
     - Activity and financial resources;
     - Planning and management of human resources;
     - Planning and management of material resources.
6. **Information and Communication in the Company**
   - Role of information and communication;
   - Collection and organization of information;
   - Strategic diagnosis;
   - Decision system.
Field: ELECTRICAL AND ELECTRONIC ENGINEERING

Specialty:

ELECTRICAL POWER SYSTEM
1. **Objective of the training**

Electric Power Technology is an instructor-led program sponsored by the Energy Providers Coalition for Education and developed for current and future electric utility workers. This program teaches students the components, design and operation of the electrical system and the equipment and safety procedures used when working with electricity. After completion of the core courses, students choose a specialization area to pursue such as line construction, metering, substation or system design. Classes begin every three to five weeks throughout the year.

2. **Research Skills**

   → **Generic skills**
   
   - Work independently and in team collaboration;
   - Analyze, synthesize professional documents (French, English);
   - Orally and writing communication (French, English);
   - Participate in (other) lead project management process;
   - Know and exploit professional and institutional networks of electricity sectors.

   → **Specific skills**
   
   - Explain all of these points in detail and provide you with the skills and knowledge necessary to calculate fault currents,
   - Select relays and associated instrument transformers appropriate to each typical system or equipment.
   - You will also learn how to adjust the setting of the relays so that the relays closest to the fault will operate and clear the fault faster than the backup devices.

3. **Career opportunities**

   - Research and development industries,
   - Engineering services firms,
   - Manufacturing
   - Maintenance technician installing electronic systems;
   - Design office designer;
   - Team leader in production unit;
   - Engineer assistant (measurements, tests and controls);
   - After Sales Service Manager;
   - Industrial production companies;
   - Maintenance company of aeronautic production sites, industry.
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
<thead>
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<th>Course titles</th>
<th>Number of hours</th>
<th>Number Of Credits</th>
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<tr>
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<td>Electrical Industry Safety</td>
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<tr>
<td>EPS114</td>
<td>Electrical Material Science</td>
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<td>EPS115</td>
<td>Electrical System Components</td>
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<td>EPS116</td>
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- **SECOND SEMESTER**

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<td>Mathematics II</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<td>Electric Machines</td>
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<td>25 15 0 5</td>
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### THIRD SEMESTER

**Field:** Electrical and Electronic Engineering  
**Specialty:** Electrical Power System (EPS)

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| **Professional courses 60% (4 UC) 18 credits 270 hours** |                                           |     |     |     |     |       |
| EPS233      | Electrical System Protection              | 25  | 15  | 15  | 5   | 60    | 4    |
| EPS234      | Digital Communication II / Pneumatic Instrumentation | 40  | 0   | 30  | 5   | 75    | 5    |
| EPS235      | Electrical Systems and System Design Analysis | 25  | 0   | 30  | 5   | 60    | 4    |
| EPS236      | Electrical Measurement and Control        | 30  | 0   | 40  | 5   | 75    | 5    |

| **Transversal Courses 10% (1 UC) 3 credits 45 hours** |                                           |     |     |     |     |       |
| EPS237      | Accounting and labour law                 | 25  | 15  | 0   | 5   | 45    | 3    |

**Total**  
225 65 125 35 450 30

### FOURTH SEMESTER

**Field:** Electrical and Electronic Engineering  
**Specialty:** Electrical Power System (EPS)

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<tr>
<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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<tr>
<td>EPS241</td>
<td>Mathematics IV</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>EPS242</td>
<td>Computer Science</td>
<td>40</td>
<td>20</td>
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</tbody>
</table>

| **Professional courses 60% (4 UC) 18 credits 270 hours** |                                           |     |     |     |     |       |
| EPS243      | Metering Technology                       | 25  | 15  | 15  | 5   | 60    | 4    |
| EPS244      | Electrical Industry and Power Grid        | 25  | 15  | 15  | 5   | 60    | 4    |
| EPS245      | Overhead Transmission and Distribution Line Construction | 0   | 0   | 60  | 0   | 60    | 4    |
| EPS246      | Internship                                | 0   | 0   | 0   | 90  | 90    | 6    |

| **Transversal Courses 10% (1 UC) 3 credits 45 hours** |                                           |     |     |     |     |       |
| EPS247      | Economics                                 | 25  | 15  | 0   | 5   | 45    | 3    |

**Total**  
155 80 100 115 450 30
5. Course content

❖ EPS 111: Mathematics I

- Mathematics: 4 credits (60 hours); L, T, SPW
  1. Functions of a real variable.
  2. Circular, hyperbolic, and reciprocal functions.
  5. Taylor Formula and limited developments.
  7. Multiple integrals and their applications to the calculation of area and volume.

❖ EPS 112: Physics and Chemistry: 4 credits (60 hours);

- Physics: 3 credits (45 hours); L, T, P, SPW
  1. Kinematics
     - Introduction;
     - Referential system and position vector;
     - Speed and acceleration;
     - Movement in the field of gravity.
  2. Action of forces on a material point
     - Principle of inertia and fundamental principle of the dynamic;
     - The superposition of Forces;
     - The forces of inertia;
     - Friction and friction forces.
  3. Gravitation
     - The force of gravitation;
     - Law of gravitation;
     - Fields of forces.
  4. Work, Power, Energy and Momentum
     - Work;
     - Power;
     - Energy;
     - Momentum.
  5. Action of the forces on a solid body
     - Static;
     - Kinetics of solid bodies.
  6. Fluid Mechanics
     - Fluid and gas at rest;
     - Incompressible liquid.

❖ Chemistry: 2 credits (30 hours); L, T, P, SPW
1. **Nuclear Reactions**
   - Describe the structure of a nucleus (Mass number, atomic number).
   - Characterization of isotopes;
   - Distinguish the different reactivity (spontaneous and non-spontaneous reaction);
   - Establish the equation of a radioactive transformation;
   - Assess the fault of mass and the energy released by a nuclear reaction;
   - Half-life of the radioactive decay;
   - Activity of radioactive isotopes;
   - Radiation protection;
   - Experimental strategy to quantify the radiation received in function of time, distance and materials crossed.

2. **Pure body and mixtures**
   - Distinguish between the different types of mixtures (suspensions, emulsions, alloys, aqueous solutions, smoke and fog);
   - Solubility of a solute in a solvent. Homogenous and heterogeneous Solutions;
   - Density of a solution, Molar concentration, Mass concentration, the molarity, molar fractions and mass concentrations.
   - Distinguish between the molar concentration of the normality;
   - Establish and apply the relations between sizes and molar mass quantities;
   - Describe and explain the operation of a process of liquid-liquid extraction;
   - Establish a balance sheet of overall material and partial to each of the constituents of a liquid-liquid extraction;
   - Articulate and apply the law of perfect gases;
   - Define the total pressure and partial pressures for a gaseous mixture;
   - Difference between absolute and relative pressure;
   - Establish the expression and evaluate the density of a real and a perfect gas;
   - Describe and explain the process of extraction liquid-gas: absorption and desorption;
   - Establish a balance sheet of overall material and partial to each of the components of an extraction liquid-gas.

3. **Chemical reactions**
   - Electronic structure of an atom;
   - Bonding (ionic and covalent bonds);
   - Molecular model of Lewis;
   - Establish an equation of reaction;
   - Establish a molar balance sheet;
   - Standard enthalpy of reaction;
   - Exothermic and endothermic reactions;
   - Chemical equilibrium of reaction: Equilibrium constant;
4. **Speed of chemical reaction**
   - Set the speed of a reaction by report to a reagent or product;
   - Define the constant speed;
   - Set the order of a reaction by report to a reagent and exploit the equation giving its concentration as a function of time;
   - Define the Time of half-reaction;
   - Identify the factors kinetics: influence of temperature and concentration from follow-up data on the reaction;
   - Explain the role of a catalyst;
   - Operate the curve giving the evolution of a composition of a reagent or a product in the time to identify the order of reaction and evaluate the speed constant and the time to half-reaction.

5. **Reaction in aqueous solution; Acidic, basic and oxido-reduction**
   - Define the specific vocabulary: acid, base according Brönsted, oxidizing, reducer;
   - Oxidation, reduction, torque acido-basic, redox couple;
   - Acido-basic reaction; redox highlighting; exchanges of protons and then of electrons;
   - Establish a link between the powers dissociating, dispersant and solvating of water and its physical properties and molecular structure;
   - Explain the particular case of the water: couples in the water, autoprotolyse, Ke, ampholyte;
   - The reactionsacido-basic;
   - Redox reactions.

6. **Organic chemistry**
   - Identify the gross formulas, developed planes, semi-developed topological and isomers of Simple hydrocarbons (alkanes, Cyclices, alkenes, benzene) and their derivatives (alcohol, carboxylic acid, aldehydes and ketones) and know the appoint;
   - Establish a link between the structure of a molecule of hydrocarbon and its chemical properties;
   - Distinguish between the three types of reactions in organic chemistry: substitution reactions, addition and elimination;
   - Distinguish monomer and polymer;
   - To distinguish the types of reactions of polymerization;
   - Describe the properties of a few industrial polymers.

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**EPS 113: Electrical Industry Safety**

- **Electrical Industry Safety: 4 credits (60h)**
  1. Basics Electrical Current
  2. History of Electrical Safety
  3. Electrical Safety Codes And Standards
  4. Common Electrical Hazards
  5. Electrical Hazard Analysis
6. Minimizing Arc-Flash and Other Electrical Hazards
7. Safe Work Practices and Electrical Emergencies

EPS 114: Material for Electrical Engineering

- Material for Electrical Engineering: 5 credits (75h)
  1. Various theories and models of the atom
     - The Rutherford-Thomson atomic models
     - The Bohr's theory of the hydrogen atom
     - Derive expression for the energy levels of the hydrogen atom
     - Explain the following phenomena in terms of 1.2
       - Spectral lines
       - Photo-electronic emission
       - Electron transmission from one energy level to another
  2. Einsteins and Plancks photo-electric equations and their applications in solving electrical engineering problems:
     - State and explain Einsteins relation
     - Compare Ensteins relation with Plancks equation
     - The photo-electric effect in terms of 2.1 and 2.2
     - Deduce threshold voltage and work function from 2.3
  3. The uncertainty and Pauli principles and their applications to the solutions of problems in electrical engineering:
     - Explain the uncertainty principles of Heinsenberg
     - Explain Pauli Exclusion principles
     - Apply 3.1 to the solutions of problems on:
       - position momentum of electrons
       - energy and time of electron transition
     - Explain the quantum numbers
     - Pauli Exclusion principle and quantum number to:
       - Determine electron configuration in atoms
       - Classify the elements in accordance with the periodic table
  4. The significance of energy band and their applications
     - Explain the energy band in solids:
     - Explain the properties of conductors, insulators and semi-conductors in terms of energy band structure.
     - Explain the overlapping of energy bands in an atom and the effects of such bands.
  5. The structure of solids and the forces which bind them together
     - Explain the crystalline nature of solids
     - Mention and Describe briefly the following crystal structures:
     - Describe X-ray diffraction to determine crystalstructure
     - Explain electron-diffraction to illustrate the dualnature of the electron.
     - Explain the various types of bonding in solids
  6. The various imperfections in solids and their effects on their properties:
Distinguish between disorders and impurities in solids
- Explain various types of disorders and impurities
- Explain Schotky and Frankel defects

7. **Thermal and optical properties of materials:**
   - Process of absorption and emission of radiation
   - Describe luminescence
   - Explain photons and phonons
   - Explain surface emission of electrons
   - Explain laser beam
   - Explain ionisation of gases
   - State practical application of each of the 7.1 to 7.6 above

8. **The important electrical and magnetic properties of some materials**
   - The piezo-electricity and its applications
   - The superconductivity
   - The Hall effect
   - Application of 8.2 and 8.3 above
   - Magnetic effects: Ferro-magnetism; Ferric-magnetismus;
     Dia-magnetismus; Para-magnetism
   - Applications of effects in 8.5 above.
   - The skin effect and its practical applications.

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**EPS 115: Electrical System Components**

- **Electrical System Components : 4 credits: (60h)**
  1. Introduction to Generation of Electric Power
  3. Voltage Levels and System Protection
  4. Transformers, Circuit Breakers, Regulators, Capacitor Banks, Tap Changers, Switch, Current and Potential Transformers, Relays and Lightning Arrestors;
  5. Types of Electrical Conductors, transmissions Structures and Insulators used to transmit Electricity

**EPS 116: Electrical power System**

- **Electrical power System: 5 credits (75 h)**
  1. **Inter-connected systems.**
     - Explain interconnected power systems.
     - State the advantages and disadvantages of interconnected power systems.
     - Explain the construction of power circle diagrams.
     - Explain the techniques for reducing interconnected systems to simple equivalents.
     - Solve problems involving 1.3 and 1.4 above.
     - Formulate the nodal admittance matrices of various networks.
     - Explain the need for load flow studies.
- State load-flow problem.
- Outline the variable (P; Q; V/S affecting loadflow in a power system network).
- Classify the variables in 1.9 into control independent and dependent variables.
- Derive the general form of the load-flow equation in:
  - Rectangular form;
  - Polar form;
- Know one method of load flow solution
- Calculate load flow analysis of interconnected systems.
- Explain the application of digital computers to load flow studies.
- Perform load flow analysis of interconnected systems,
- Write a computer program to perform load flow analysis of a simple power network.
- Execute item 1.6 in a computer.

2. The performance of fault analysis of interconnected systems.
   - Explain the various types of faults that occur on generators and transformers.
   - State the various types of faults that occur on transmission lines.
   - Explain short circuit, open circuit and earth faults on lines.
   - Define transient and sub transient reactance.
   - Explain sub transient and transient reactance using the appropriate wave form of a faulted generator.
   - Draw typical wave forms of short circuit currents in power systems.
   - Define the peak short circuit current (dynamic) using the wave form of 2.6 above.
   - Explain a symmetrical fault.
   - Solve symmetrical fault problems using line diagrams and per unit method.
   - Explain positive, negative and zero sequence components.
   - Derive expressions for the symmetrical components mentioned in 2.14 in terms of the line values.
   - State the expression for power in symmetrical components.
   - Define unsymmetrical faults (single line to ground, double line to ground, etc.)
   - Explain unsymmetrical fault problems using the symmetrical component networks.
   - Identify the sequence impedances of power system components.
   - Find the sequence network for a given power system.
   - Solve unsymmetrical fault problems using the principles of symmetrical components.
   - Calculate the MVA fault level on typical power systems.
   - Explain methods of selecting switchgear, bus-bars, fuses for typical fault levels.
3. **The system over voltages and insulation requirements.**
   - Explain corona and factors affecting it
   - State the various effects of corona
   - Derive a formula for the disruptive critical voltage for an overhead line
   - Explain the causes of over-voltages in power systems
   - Draw a typical surge wave form
   - List the possible effects of a travelling wave on a transmission system
   - Derive an equation for the surge velocity in a uniform line
   - Solve, using 3.7, problems on:
     - Surge velocity in a single-phase overhead line in air
     - Surge velocity in a three-phase overhead line in air
     - Surge velocity in a single-phase concentric cable
   - Deduce an expression for the surge impedance (Zo)
   - Explain the different types of terminations
   - Deduce an expression for reflected surge voltage and current, and transmitted surge voltage and current
   - Define the following:
     - Reflecting factor of coefficient (p)
     - Transmission factor of coefficient (t)
   - Solve problems on surges using 3.9 and 3.11 above.
   - Describe the protection of transmission lines against lightning surges.
   - Draw graph for voltage and current surges when R is greater than Zo and explain the graph.
   - Explain the effect of a surge on an overhead line terminated by a transformer.
   - Deduce expressions for reflected voltage and current surges in an open circuited line and short-circuited line.
   - Solve problems involving line/cable junctions using the derived equations in 3.18 above.
   - Describe various types of overhead line insulators and state their uses.
   - Describe various methods of testing insulators.
   - Deduce an expression for the voltage distribution across an insulated string.
   - Solve problems on voltage distribution and string efficiency of insulators.
   - Explain insulation co-ordination in overhead lines.
   - Explain the operation of an impulse generator.
   - Explain the wave shape obtained from an impulse generator

4. **Different types of Substations and their equipment**
   - Define a substation
   - Sketch a typical layout of a substation
   - Explain the following:
     - Grid Substation
     - Distribution substation
     - Industrial substation
- Switching substation.
- Domestic substation.
- State advantages and disadvantages of outdoor substations as compared to indoor substations.
- List factors to be taken into consideration when deciding the site of a substation.
- Explain the functions of the following in a substation:
  - Switch gears
  - HRC Fuse links
  - Reactors
  - Lightning arrestors
- Draw a single line diagram of the following systems:
  - Back-to-back duplicate bus-bar with tie-bar reactors
- Describe the principle of operation and control in electric circuit breaker
- Sketch the wave form of arc extinction
- Explain the following:
  - Restriking voltage;
  - Recovery transient
  - Current Chopping.
- Describe Rupturing Capacity, Making Capacity, Short-time rating as applied to circuit breakers.
- Describe with the aid of fully labeled diagram the operation of each of the following:
  - Oil circuit breaker
  - Air blast circuit breaker
  - SF6 circuit breaker
  - Vacuum circuit breaker
  - HRC fuse
  - Fused Switch
  - Isolator
  - Lightning Arrestors.

5. The principle of operation of power system protection and its applications.
- Explain the need for a protective scheme in a power system.
- State the requirements of a protective scheme namely:
  - Reliability
  - Discrimination
  - Sensitivity
  - Selectivity
  - Simplicity and economy.
- Explain zones of protection of a protection system highlighting the need for overlapping.
- Describe the operation of the components of a protective system viz relays CTs & PTs
Classify relays as static and electro-magnetic types.
State the merits and demerits of each in 5.5 above.
Describe various types of electro-mechanical relays.
Sketch the circuit connection for a sequence filter for producing zero, positive and negative sequence components.
Analyse the circuits of 5.8 to obtain the components.
Sketch a schematic diagram of a two-input relay comparator circuit.
Derive expressions for the comparator input voltages.
Derive expressions for the operation condition of a relay comparator in:
  – Amplitude comparison mode
  – Phase comparison mode.
State parameter choices for obtaining the ohm, mho and impedance relay characteristics obtained in 2.13 above.
Sketch the characteristics obtained above on R – X diagrams.
Explain with the aid of diagrams the following:
  – Over current relay
  – Distance relay
  – Directional over current relay, etc.
Explain differential protection.
Explain, with the aid of diagrams main protective schemes for generators, power transformers, feeders and bus-bars.
Explain inverse-time overcurrent relay.
Explain the current (ug) setting and line-setting multipliers for overcurrent relays.
Use I.D.M.T.L. characteristics curves to solve problems relating to overcurrent relays.
Select relay settings to protect various system configurations.
Solve problems on power system protection.

* MIS 117: Bilingual training *

➢ **English : 1.5 credits (22 hours 30mn)); L, T, SPW**

1. **Vocabulary**
   - Technical and usual vocabulary of the specialty
2. **Grammar**
3. **Bilingual expression**
   - Understanding in interaction in Technical Discussions
   - Continuous oral communication: Show, explain, develop, summarize, account, comment;
   - Interactions oral communication
4. **Autonomous reading of “writings” of all levels**
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
• Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. **Write clear, detailed texts**
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

➢ **French**: 1.5 credits (22 hours 30mn); L, T, SPW
   1. **Vocabulaire**
      - Vocabulaire technique et usuel
   2. **Grammaire**
      - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
      - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
      - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
      - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
      - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
      - Des fonctions grammaticales.

3. **Expression et communication**
   - Compréhension et interaction au cours d’une discussion technique ;
   - Communication orale courante ;
   - Communication orale interactive ;
   - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
   - Lecture rapide et compréhension de texte ;
   - Synthèse de texte
   - De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
   - Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
   - Expressions figées

➢ **MIS 121: Mathematics II**

➢ **Mathematics II**: 4 credits (60 hours); L, T, SPW
   1. Numerical Sequences
   2. Numerical Series
3. Fourier Series
4. Laplace transformation
5. Fourier transformation
6. Multi-variable functions- Scalar and vectors fields and their applications

❖ MIS 122: Physics and Computer Science

➢ Physics II : 2 credits (30 hours); L, T, P, SPW

A. Oscillations and Waves

1. Kinematics of oscillating bodies
   ▪ Generalities ;
   ▪ The harmonic oscillator;
   ▪ Superposition of oscillations.

2. Dynamics of oscillating bodies
   ▪ Free and damped oscillations
   ▪ Forced and coupled oscillations.

3. Waves
   ▪ Generalities ;
   ▪ Harmonic waves; Groups of waves; Energy transport;
   ▪ The superposition of waves;
   ▪ Reflection, refraction and diffraction of waves;
   ▪ Sound waves and ultrasound.

➢ Computer Science I : 3 credits (45 hours); L, T, P, SPW

1. Generalities and vocabulary
   ▪ Concept of information and informatics;
   ▪ Resolution of problems by the informatics;
   ▪ Typology and computer configuration;
   ▪ Fields of application of informatics;

2. Information representation and processing
   ▪ Systems of numbers;
   ▪ Representation of Numbers and Characters (coding of information);
   ▪ Booleanlogic;
   ▪ Circuits of calculations & memory;
   ▪ Presentation and differences between numerical & non-numerical data.

3. Structure and operation of a micro-computer
   ▪ Architectures of a micro-computers;
   ▪ Functional units (Central Unit, Units of entry and exit);
   ▪ Architecture and performance of microprocessors;
   ▪ Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
   ▪ Presentation and roles of programs; their applications.
4. A Computer : An Interface “Machine (Hardware) - Man (Software)” as solutions to problems
   - The bios;
   - The systems of applications;
   - Application programs.
5. Operating systems and examples of operating system
   - WINDOWS (DOS);
   - Linux: an interesting alternative;
6. A few examples of applications software
   - The "Package Microsoft Office" (Word, PowerPoint, Excel);
   - The software of navigation and search engines on the Web.

EPS 123: Electrical Circuit Theory I & II

Electrical Circuit Theory I: 5 credits (75h)

1. Evaluation the responses of various networks to a momentary increase of current and voltage
   - Explain the phenomenon of transients as a response which may finally decay after a time.
   - Explain transients in reactive circuits (inductive and capacitive).
   - Derive the equation for the growth of current in an inductive circuit (D.C.)
   - Derive the equation for the decay of current in an inductive circuit.
   - Solve network problems, using the equations derived in 1.3 and 1.4 above.
   - Derive the equation of growth and decay of current in R-L-C circuit.
   - Apply 1.6 above to the solution of network problems e.g. tuned circuits (parallel & series)
2. The performance of transmission lines.
   - Define a transmission line
   - Explain the general Primary line constants of a transmission line.
   - Derive an expression for the propagation coefficient from the primary line constants.
   - Define the secondary line constants.
   - Derive an expression for the line characteristics impedance.
   - Derive expressions for the voltage and current at the ends of an infinite line.
   - Define a general termination impedance of a line.
   - Evaluates the input impedance,
   - Explain the two special cases of line termination:
     - Open circuit line;
     - Short circuit line
   - Solve Transmission line problems by
     - Calculations
3. Graphical methods to the solution of network problems
   - Explain locus and polar diagrams
   - Explain the concept of complex frequency
   - Determine amplitude and phase response curves graphically
   - Determine amplitude and phase from pole-zero diagrams
   - Explain Bode plots.
   - Solve related problems in 3.1 to 3.5 above.

> Electrical Circuit Theory II

1. Laplace transform to the solution of electrical network problems.
   - Define the Laplace transform of a given function
   - State the transforms of common functions
   - Explain the first shift theorem
   - Define the inverse Laplace transform of a given function
   - Perform partial fraction reduction of a given function
   - Define poles and zeros of a function
   - Plot poles/zeros diagram of a function
   - Write down the equations for parallel and series RLC circuits in terms of laplace transform
   - Identify the order of the equations in 1.8 above
   - Solve circuit problems using laplace transform
   - Define the Heavi-side unit step function
   - Explain the second shift theorem
   - State the transform of period functions
   - Perform the inverse transforms of a periodic function
   - Explain the Dira-Delta impulse function
   - Define the function \( f(t-a), f(t), f(t + a) \)
   - Explain the transform of the function \( f(t-a), f(t) \) and \( f(t + a) \)
   - Explain the following theorems and use the theorems in solving problems:
     - Initial value theorem
     - Final value theorem

2. The performance of transmission lines
   - Explain the general Primary line constants of a transmission line.
   - Derive an expression for the propagation coefficient from the primary line constants.
   - Define the secondary line constants.
   - Derive the expression for the line characteristics impedance.
   - Derive expressions for the voltage and current at the ends of an infinite line.
   - Define a practical transmission line.
   - Define a general termination impedance of a line (Zr.)
   - Evaluates the input impedance. (Zs)
   - Explain the two special cases of line termination:
– Open circuit line;
– Short circuit line

- Derive expressions for a loss-free line:
  - Propagation coefficient
  - Attenuation coefficient
  - Phase change coefficient
  - Characteristics impedance.

- Sketch waveform and current distribution along a line when it is terminated in:
  - Short circuit
  - Open circuit

3. The performance of transmission lines
- Derive expressions for the reflection coefficient of a line.
- Define voltage standing wave ratio (V.S.W.R.) in relation to:
  - Vmax and Vmin,
  - Reflection coefficient
  - Termination and characteristic impedance.
- Solve problems using 2.1 - 2.13 above.

- Describe the principles of stub matching
- Describe the Smith Chart and its application
- Explain matching of load to line with a quarter wave transformer.
- Explain matching of load to lie with short circuit stub.
- Describe the effect of frequency variation on line matching.
- Solve transmission line problems by:
  - Calculation
  - Graphical methods.

EPS 124: Electrical Design and Drafting: 4 credits (60h)

- Electrical Design and Drafting: 4 credits (60h)

1. Electricity supply to various types of consumers
- Explain the terms:
  - Consumer distribution
  - Main switchgear
- State various voltage at which supplies are sent to consumers
- Draw main switchgear permissible combinations
- Distinguish domestic premises from nondomestic premises.
- State the types of supplies which are normally sent to domestic premises and non-domestic premises.
- Define consumers control unit, splitter units
- Explain the differences between single-pole, double-pole and triple pole consumer units.
- State the types of fuses normally found in consumer units
- Explain spare ways and the purposes they serve in consumer unit
- Explain the purpose of distribution board
- State the factors to be considered when selecting a consumer unit or distribution board
- State the factors to be considered when selecting a consumer unit or distribution board
- Draw a three phase line in diagram and explain how the loads are balanced on it.
- Define sub-circuits, circuit charts, main circuits.
- Draft typical internal distribution schemes for block of three flats, and multi-storey and identify the various items in the scheme

2. Electricity supply to various types of consumers
- Define diversity factors
- Explain how power is supplied to large buildings such as blocks of flats
- Explain the following:
  - Main switch gear (lower block)
  - Busbar chamber, and
  - Rising mains
- Draft rising main busbar system diagram serving high rise flats and explain it
- Explain the use of bare conductor rising mains
- Draft layout of switchgear for typical office building (including the legends)
- Draft layout diagram for typical factory distribution system (including the legends)
- Explain overhead busbar trunking systems and how they are used to distribute electricity in factories
- Draft an industrial cubicle Switchboard
- Identify the main components on a switchboard.
- Explain how electricity is distributed in farms
- Identify types of equipment used in farm installations Explain basic design concepts for the preparation of the electrical drawings
- Design electrical services for the following:
  - Bungalows
  - flatsc. estates
- Draft a plan for each of above.

3. The selection of cables and the parameters that affect their selection
- Explain the following terms in connection with cable selection
  - Length of run
  - Ambient temperature
  - Class of excess current protecting
  - Grouping of circuits
  - Disposition
  - Types of sheath
- Identify the various tables in the current IEE Regulations and NSE CAPS used for cables selection
4. Types of diagrams and use them in various design situations.
   - Define wiring diagrams
   - List the various types of wiring diagrams and their uses.
   - State the advantages and disadvantages of various wiring diagrams
   - Define point-to-point diagrams
   - Draft point-to-point diagrams
   - Solve problems involving point-to-point diagrams
   - Define baseline diagrams
   - Draft baseline diagrams
   - Solve problems involving baseline diagrams
   - Define highway diagrams
   - Draft highway diagrams
   - Solve problems involving highway diagrams
   - Define lineless diagrams
   - Draft lineless diagrams
   - Solve problems involving lineless diagrams
   - Draft various design using wiring diagrams

5. The basic principles of illustration and the selection of fittings for specific purposes
   - Explain the following as regards light distribution:
     - Direct fitting
     - Indirect fitting
     - Semi-direct fittings
   - Draw:
     - Direct fitting
     - Indirect fitting
     - Semi-direct fitting
   - State factors which should be taken into consideration when selecting a lamp fitting.
   - Explain Maintenance Factor and co-efficient of utilization as used in lumen method of illumination calculation.
   - Derive formula for the calculation of number of fittings.
   - Identify the various parameters in the formula.
   - Solve various problems using the derived formula in 4.5 above.
   - Explain point-to-point method of illumination level estimation using the cosine law.
   - Solve various problems on illumination level calculations using the cosine law.
   - Explain Polar curves.
   - Solve problems on illumination.
   - Select lamp fitting for various purposes.
1. **Signals and their properties**
   - Types of signals
   - Continuous - time signals
   - Discrete - time Signals
   - Properties of signals
   - Fourier series etc.

2. **The principles of digital modulation**
   - Explain the term digital modulation
   - Explain the principles of operation of digital modulation
   - Sketch the spectrum diagram of the systems defined in 2.2
   - Analyse the frequency components of a pulse using Fourier series
   - Sketch the block diagram of a P.A.M. (Pulse Amplitude Modulation) transmitter and receiver.
   - Explain the disadvantages of the PAM system.
   - Explain with the aid of sketches, a time division multiplexing principle.
   - Solve problems on digital modulation

3. **The principles of amplitude and frequency demodulations.**
   - Explain the term “demodulation
   - Explain the action of a semi-conductor diode as a simple detector.
   - Deduce mathematically that the output of a non-linear device with an AM input contains the information signal and other signal components.
   - Explain the square law detector
   - Derive expression for the output of the square law detector.
   - Sketch the output waveform of the square law detector.
   - Explain coherent detection principles for detecting DSBSC signals.
   - Derive expressions for the output of a coherent detector using analytical methods.
   - Describe the operation of a circuit diagram that used the principles of coherent detection.
   - Solve problems involving detection of AM waveforms.
   - Explain, with aid of diagrams, the operation of the following FM detectors:-
     - Forster
     - Ratio detector;
   - Explain with aid of diagrams the concepts of pre-emphasis and de-emphasis

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**EPS 126: Electrical Machines**

1. **Electrical Machines: 5 credits (75)**

   1. The fundamental principles of electrical machines.
- State the principles of induction, interaction and alignment as applied to electrical machines.
- Explain with the aid of sketches how the principles above (1.1) are applied to electrical machines.

2. The principles of electro-mechanical energy conversion
   - State the major energy conversion principles.
   - Derive the general energy balance equation applicable to all situations
   - Represent by suitable block diagrams the energy balance equation.
   - Derive induced voltage and electrical energy input in singly excited systems.
   - Derive the energy in the magnetic field of a singly excited system.
   - Derive the mechanical force in the system in 2.5 above.
   - Derive energy balance equation.
   - Develop the dynamic equation of singly excited electro-mechanical system.
   - Solve problems involving 2.2 to 2.7 above.

3. The principles of operation and construction of transformers
   - Explain the working principle of the transformer
   - Develop the end equation of a transformer
   - Describe the different types of transformer cores and windings.
   - Explain resultant magnetic flux, magnetic inductance, leakage fluxes and inductances.
   - Explain the phase diagrams for transformer on no-load and on-loaded conditions.
   - Explain the equivalent circuit of a transformer
   - Identify the limitations of the equivalent circuit and the approximate equivalent circuit. Use the open-circuit test and the short-circuit test to
   - Determine the equivalent circuit parameters.
   - Derive equations for the efficiency and voltage regulation.
   - Connect three single phase transformers for those phase operation
   - Show with the aid of sketches the possible arrangement of three transformer windings.
   - Group transformers into their vector groups.
   - Explain the use of each group and their advantages.
   - Explain the purpose of the tertiary windings in three phase transformers.
   - Explain the parallel operation of three phase transformers.
   - Derive expression for load sharing of transformers connected in parallel.
   - Describe methods of testing transformers namely
   - Routine test during life span of the transformer
   - Differentiate between power and distribution transformers.
   - Explain the effects of temperature rise on transformers.
   - Describe methods of cooling transformers
   - Explain the limitation of each method
- Explain the source of vibration and noise in transformers
- Explain voltage control by tap changing
- Explain the causes of harmonies in transformers

4. Laboratory Experiments
- Single and three phase transformer connections and characteristic parameters.
- Heat Run and regenerative efficiency test in two single phase transformers
- Parallel operation of Transformers
- Connection of three single phase transformers to form a single - three phase transformer, and characteristic parameters.
- Experiments on principle of electrical machines
- Experiments on energy conversion

EPS 127: Business Creation / Civic and Moral Education

- Entrepreneurship: 1 credit (15 hours) ; L, T, SPW
  1. Entrepreneur concept
  2. Motivations for starting a business
  3. Ideas research and evaluation
  4. Financing research
  5. Choice of legal status

- Civic and moral education: 2 credits (30 hours); L, T

  The Concepts
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem ;
  - Ethics and management.
  - Civics
  - Deontology
  - Moral consciousness
  - The universal declaration of Human Rights
  - Good governance in public services
  - The importance of civics to the life of the nation
  - Functions of the state and its citizens
  - Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics

**EPS 231: Mathematics III**

- Mathematics III : 4 credits (60 hours); L, T, SPW
  1. Linear systems
  2. Complex numbers
  3. Polynomials functions and rational fractions
  4. Vector spaces and Euclidean vector spaces
  5. Linear applications
  6. Matrices

**EPS 232: Physics and chemistry III**

- Physics III : 3 credits (45 hours); L, T, P,SPW
  1. Thermodynamics
     - Temperature and thermal expansion;
     - Heat and fundamental principle of thermodynamics;
     - Change of state of the ideal gases;
     - Kinetic theory of heat;
     - Cyclical process: 2nd fundamental principle of thermodynamics;
     - Change of state;
     - Propagation of heat.
  2. Electrodynamics and applications
     - Currents and fields;
     - Production of magnetic fields;
     - Induction phenomenon;
     - Alternating current;
     - Electromagnetic waves.

- Chemistry: Basics of Quality, Health, Safety and Environment 2 credits (30 h; L, T, P, SPW)
  1. Management system of a company
     - Identify the management system of a company using the global standards ISO 9001 and 14001;
     - Use and master the vocabulary of management systems.
  2. Fight against nonconformities and loop of continuous improvement.
     - Use and master the vocabulary of continuous improvement;
     - Identify the implementation of the continuous improvement loop, regardless of the domain or company involved: ascertain, isolate / contain, analyze causes, treat causes, measure effectiveness;
- Identify nonconformities, their degree of severity and their consequences in any context;
- Propose corrective and preventive actions, even improvement, within the limits of its field of intervention;
- Respect the rules of traceability within the limits of its field of intervention.

### 3. Risk analysis and prevention.
- Participate in a risk prevention analysis;
- Participate in a dynamic risk impact analysis;
- Implement a prevention plan or emergency plan in its area of intervention.

### 4. Regulations and technical standards.
- Situate its action within the framework of the operational technical standards developed by the IEC TC 65: for example the IEC 61508, IEC 61326, IEC 62443, IEC 62424, IEC 62708 series, etc.
- Recognize the pictograms, hazard classes and precautionary and prevention statements of the CLP Regulation;
- Apply the rules of prevention, limitation or prohibition related to the REACH Regulation on substances and their uses, whether in the form of raw materials, in mixtures, or contained in "articles";
- Apply ATEX regulations related to the control of risks related to explosive atmospheres;
- Comply with the sorting instructions for end-of-life CIRA equipment, issued by the Waste Electrical and Electronic Equipment (WEEE) Directive.

#### EPS 233: Electrical System Protection

- **Electrical System Protection: 4 credits (60)**
  1. Problems on electrical systems: Short circuits; fault conditions; Equipment failures
  2. Purpose of System Protection: public protection; Improving system stability; Minimizing damage to equipment; Protection against overloads; Employment of relay technics
  3. Components (Equipment) to protect: Generators; Transformers, Reactors; Lines; Buses; Capacitors

#### EPS 234: Digital Communication II /Pneumatic Instrumentation

- **Pneumatic Instrumentation: 2 credits (30h)**
  1. Explain the operation of pneumatic Instrument.
  2. Calculate and set the gains of pneumatic Controller
  3. Install and calibrate pneumatic Instruments
- Digital Communication II: 3 credits (45h)

General Objectives
- Design and Construct simple Channel encodes
- Design and construct simple data modulations
- Appreciate the role of digital communication in globalization.

1. **Principles of operation of amplitude and frequency modulated radio transmitters.**
   - Draw the block diagram of an AM radio transmitter indicating:
     - RF Amplifier;
     - Oscillator stage;
     - Modulator stage;
     - AF Amplifier.
   - Explain the functions of each stage of the blocks indicated in 1.1 above.
   - Draw the blocks diagram of an FM radio transmitter, indicating:
     - AF stage;
     - Varactor modulator;
     - Crystal Oscillator
     - AFC circuit;
     - LC Oscillator;
     - Frequency multiplier;
     - Power amplifier.
   - Explain the functions of each block above.
   - Explain the types of coupling methods from the amplifier stage to the aerial.
   - Describe the types of measuring instruments needed to test a transmitter
   - Explain the methods of testing a transmitter.
   - Sketch the block diagram of a radio point-to-point system for HF transmission.
   - Explain the operation system used above.

2. **The principles of operation of AM, FM radio receivers.**
   - Explain with aid of block diagrams, the principles of operation of a double superhet receiver.
   - State the advantages and applications of a double superhet receiver.
   - Explain with the aid of block diagrams, the principles of operation of AM receivers.
   - Explain, with aid of block diagrams, the principles of operation of FM receivers.
   - Describe with the aid of a block diagram, the principles of operation of a transceiver.
   - Describe the uses of print-to-point system and a transceiver.
3. **The construction and principle of operation of monochrome and colour**
   - Describe the construction and operation of a typical T.V. camera.
   - Explain with the aid of a block diagram, the principle of a monochrome TV Transmitter.
   - Explain the generation of line and field synchronization pulses.
   - Describe how synchronization signals are added to the video signal in the T.V. camera.
   - Describe how sound and video signals are mixed in the transmitter.
   - Explain the scanning process.
   - Explain the following terms with respect to T.V. transmission:
     - Visual acuity;
     - Aspect ratio;
     - Flicker effect
   - Describe vestigial modulation
   - Explain quadrature distortion
   - Sketch I.F. amplifier response
   - Sketch a labelled complete video signal
   - Explain the terms: a. gamma correction b. system gamma
   - Describe AGC and AFC principles as applied to Television.
   - Explain with the aid of block diagram, the principle of a monochrome TV receiver and explain the function of each block.
   - Explain how the received signal is converted into picture in the C.R.T.
   - Explain the functions of: a. The aquadag; b. The focus coil; c. The E.H.T.
   - Describe the various types of colour television systems in use: (NTSC, PAL, SECAM).
   - Describe the type of system used in Cameroun.
   - Describe the colour television Camera system;
   - Explain Colorimetry and the specification of Colour (uses of primary colours).
   - Explain, with aid of a block diagram the principle of operation of a colour TV Transmitter.
   - Explain, with the aid of a block diagram, the principle of operation of a colour TV receiver.
   - Explain noise power with given temperature.
   - Derive expressions for:
     - Noise figure;
     - Minimum detectable signal
     - Maximum range.
   - Sketch the block diagram of a non-zero IF receiver
   - Explain signs of radia velocity
   - Sketch a block diagram to illustrate the phasing methods
   - ist the advantages and disadvantages of the C.W. radar
   - Sketch a block diagram of the FM – CWRadar
   - Solve problems on Radar communications.
4. The construction and principles of Telephone, Telefax and Switching systems.
   - Describe the basic telephone system
   - Explain types of switching methods e.g. (Magneto, Central, Central-battery and automatic dialing)
   - Explain the basic system structure (exchange hierarchy)
   - Draw the circuit diagram of a local signaling system (principles of loop-disconnect signaling).
   - Explain inter-exchange signaling
   - Explain multi-exchange connections
   - Explain the principles of international calls
   - Describe the CCITT interface
   - Describe the following systems:
     - Telex;
     - Telefax
     - Facsimile
   - Explain the following multiplexing systems:
     - Time division multiplexing;
     - Frequency division multiplexing.
   - Describe a multi-channel transmission system
   - Describe the set up of a telephone Exchange.

EPS 235: Electrical System and System Design Analysis

- Electrical System and System Design Analysis: 4 credits (60h)
  1. Electric Utility Industry Structure
  2. Making Microgrids Work
  3. Manages Aging Transformer Fleet
  4. Transmission Line Conductor Design
  5. Symmetrical Faults and Unsymmetrical Faults: The ABCs of HVDC Transmission Technologies
  6. The Problem of Arcing Faults in Low-Voltage Power Distribution Systems;
  7. Symmetrical Components: Circuit Breakers Go High Voltage
  8. System Protection
  9. Transient Stability: Design Methods for Improving Transient Stability
  11. Introduction to Distribution

EPS 236: Electrical Measurement and Control

- Electrical Measurement and Control: 5 credits (75h)
  1. Temperature Measuring System
     - Define Units of Temperature e.g. Kelvin, Fahrenheit, Absolute Centigrade etc.
Covert from one Unit of temperature to another.
- Identify temperature measuring systems e.g. filled system, thermocouples, resistance, thermometry, Thermistors, bimetallic, pyrometers, Quartz Crystal.
- Classify the different types of the temperature measuring systems.
- Explain the Principles of Operation and the Constructional features of each type.
- State the advantages and disadvantages of each system.
- Calibrate temperature measuring devices such as thermometers, thermocouples etc.
- Using standard calibrating equipment e.g. Sand batch, Oil bath etc.
- Install temperature measuring devices using the correct technique.

2. The techniques of pressure measurement
- Define the limits of measurement of Pressure
- Convert from one Pressure Unit to the other.
- Define pressure as force/Unit area.
- Define the following terms used in pressure measurements - atmospheric, gauge, absolute, differential, vacuum pressures.
- Identify and explain the principle of operation of the different methods of Pressure Measurement, Select and use measuring Instruments,
- State the advantages and disadvantages of each measuring Instruments.
- Identify and use Calibrating devices.
- Calibrate Pressure measuring devices, Observing safety precautions.
- Explain the Constructional features and operational Principles of Pressure measuring devices and Calibrating devices.
- Install service and maintain pressure measuring devices.
- Explain methods of installation of measuring instruments.
- Dismantle and assemble pressure measuring instruments.

3. Flow measurement
- Define Units of flow measurement e.g. Cubic litre/hour etc.
- Explain the types of flow e.g. Laminar, turbulent etc.
- Differentiate between compressible and non compressible fluids.
- State Compressibility factor.
- Explain Reynolds number
- Explain Viscosity
- State and explain Bernoulli Theorem
- Derive Bernoulli equation
- Select and use flow measuring devices
- Measure fluid flow in closed Pipes using differential pressure meters, e.g. Orifice plate, Venture - tube, Dal tube flow Rozzles etc.
- Explain the operational Principles and Constructional features of the flow DP measuring devices mentioned above.
- Name and explain the constructional features and the operational Principles of different types of Orifice plates.
Select and Instal different types of Orifice Plates.
State the units, advantages and disadvantages of the above named types of Orifice plates.
Employ the following tapping methods
Define impulse lines.
Explain the following terms – cast ports cooling chambers, flangers and flange ratings.
State Units of measurement in actual Volume, reduced volume weight unit.
State HP ratio
State formula for hot liquids near boiling point \((h) = (p-p)\)
State and explain Reynolds number
State Velocity of approach factor and Co-efficient of discharge \(R = \frac{dve}{3}\)
Carry out Orifice plate Sizing, using the following parameters: diameter ratio \((d/D)\), Reynolds number, \(J – Value\) etc. Explain the constructional features and the operational
Principles of the following flow meters - Rotameters, Magnetic, Turbine Positive displacement, Doppler etc.
Select, install and maintain the above flow meters.
State the areas of application, the advantages and disadvantages of each of the above named flow meters.
Explain the Constructional features and the Principles of Operation of the Weirs and Parshall Flumes flow meters.
Apply Weirs and Parshall Flumes meters in measurement of fluids in open channels.

4. **Level measurement and apply it in vessel**
- State the Units of level measurement e.g. Metre, feet etc.
- Name different types of level measuring instruments Flort, displacement, capacitance, ultrasonic, radiation, DP, diaphragm level guages etc.
- Explain the Principles of operation of the level measuring instruments named above.
- Explain the Constructional Features of Level measuring devices.
- State the advantages and disadvantages of the level measuring devices.
- Select and install service and maintain level measuring devices.
- Explain the application of level measuring devices in Open and Closed Vessels.

5. **Instrumentation Symbols**
- Identify and draw instrumentation Symbols
- Write Instrumentation and control abbreviations
- Use tag numbers to identify component parts of a control system
- Identify loop drawings in the Piping and Instrument diagrams by using symbols and tag numbers
- Translate sequences of operation from logic Circuit diagram to electrical circuit diagram.

6. **The safety Precaution necessary during Installation & maintenance of instrument and control devices.**
   - State the safety devices necessary for the installation or instrument and control devices, Pressure relief Values, Rupture, Discs, Flame arrestor, Flammable detector.

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**EPS 237: Accounting and Labour Law**

- **Accounting:** 1 credits (15 hours); L, T
  1. General information on cost accounting and business management
     - Objective;
     - Role;
     - Concept of charge.
  2. Charge analysis
     - Embedded expenses;
     - Direct, indirect costs;
     - Valuation of stocks.
  3. Full cost method
     - Purchase cost;
     - Cost of production;
     - cost price;
     - Calculation of results.

- **Labour Law:** 1 credit (15 hours); L, T

  **A- First part**
  1. The concept of Law;
  2. The characters of the Law Rule;
  3. Sources of Law (Hierarchical norms);
  4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
  5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
  6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression).

  **B- Second part**
  1. Sources of Labour Law
  2. The different employment contracts (classic contracts and precarious contracts)
  3. Execution of the employment contract (salary and salary claim, various professional sanctions)
  4. Dismissal and resignation;
  5. Resolution of labor disputes
EPS 241: Mathematics IV

Mathematics IV: 4 credits (60 hours); L, T, SPW
1. One-dimensional descriptive statistics;
2. Linear regression;
3. Calculation of probabilities;
4. Laws of probability;
5. Sampling and
6. Estimation method;
7. Chi-square hypothesis test.

EPS 242: Computer Science II

Computer Science II: 5 credits (75 hours); L, T, P, SPW
1. Introduction
2. Fundamental elements
   ▪ Problem and algorithm;
   ▪ Program and programming language;
   ▪ From the problem to the computer solution;
   ▪ The paradigms of programming;
3. Concepts of programming in C++
   ▪ Presentation and description of the programming language;
   ▪ Structuring a program;
   ▪ Descriptions of Data, Actions;
   ▪ Programming style.

EPS 243: Metering Technology

Metering Technology: 4 credits (60h)
1. Fundamentals of Metering: Terminology and Basic Principles Of Meters
2. Basic Math Needed In Metering
3. Basic Electricity and Magnetism Principles
4. Meter Testing Equipment, Meter Diagrams and Standards
5. Technical Data
6. Reading Watt Hour and Demand Meters
7. Various Metering System Designs and Application Options
8. Metering System Components
9. Wiring Configurations and Instrument Transformer Variations
10. Ratio, Burden, and Correction Factor Calculations
11. Functional Testing, And Calibration Procedures
12. Safe Installation Procedures
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<td>Electrical Industry and power Grid</td>
<td>4</td>
<td>60</td>
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<tr>
<td>EPS 245</td>
<td>Overhead Transmission and Distribution Line Construction</td>
<td>4</td>
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<td>EPS 246</td>
<td>Professional internship</td>
<td>6</td>
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<tr>
<td>EPS 247</td>
<td>Economy and business organization</td>
<td>3</td>
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### EPS 244: Electrical Industry and power Grid: 4 credits (60h)
- **Introduction to The Systems And Components**
- **Basic Electrical System: Generation, Transmission and Distribution**
- **System Operations and Marketing of Electricity**
- **Utility Sectors of the Electrical Industry: Investor-Owned, Publicly Owned And Cooperatively Owned Utilities**

### EPS 245: Overhead Transmission and Distribution Line Construction
- **Overhead Line Design Standard**
- **Overhead Line Ratings**
- **Transmission and Distribution**
- **Distribution design Aspects**
- **Major line components (structures, conductors)**
- **Structural design (working stress and limit state)**
- **Impacts of Embedded Generation**
- **New Technology on Distribution Networks: Satcom LV Regulator; Ground Fault Neutralizer; Sparkles Fuses; S&C switch.**

### EPS 246: Professional internship
- **Arrival and integration in the companies**
- **Work in a company**
- **Keeping the trainee journal**
- **Choice of the working theme in collaboration with the professional supervisor and the academic supervisor**
- **Development of the research framework**
- **Resources to exploit**
- **Organization of work**
- **Writing the report**
- **Presentation of the report before a jury**

### EPS 247: Economy and business organization
- **Concepts of General Economics**
  - Introduction;
  - Consumption and production;
  - Income training;
2. The Company
   - Introduction;
   - Typology of companies;
   - Structure and organization of the company;
   - Business and Ethics;
   - How to undertake (Create, Decide, and Manage).

3. The place of the company in the economic environment
   - Concept of the business environment;
   - Inter and extra-company relations;
   - Commercial activity;
   - Concept of Strategy.

4. Productive activity
   - Production policies and processes;
   - Trade policies;
   - Logistics.

5. The Concept of Management in the Company
   - Activity and financial resources;
   - Planning and management of human resources;
   - Planning and management of material resources.

6. Information and Communication in the Company
   - Role of information and communication;
   - Collection and organization of information;
   - Strategic diagnosis;
   - Decision system.
Field: ELECTRICAL AND ELECTRONIC ENGINEERING

Specialty: MAINTENANCE OF INDUSTRIAL SYSTEM
1. **Objective of the training**

This specialty aims to train senior technicians able to maintain and ensure good levels of productivity of increasingly complex machines involved in the process of industrial production. It therefore refers to the management of production processes which, in addition to the state-of-the-art technologies such as computer-aided design, industrial robotics and computer-aided manufacturing, requires new approaches to production-oriented training.

2. **Research Skills**

   → **Generic skills**
   - Work independently and in team collaboration;
   - Analyze, synthesize professional documents (French, English);
   - Orally and writing communication (French, English);
   - Participate in (other) lead project management process;
   - Know and exploit professional and institutional networks of electricity sectors.

   → **Specific skills**
   - Analyze equipment operation and carry out maintenance work;
   - Organize and optimize maintenance activities;
   - Design solutions for improvement and integration of equipment and adaptation for the installation of new components;
   - Check and regularly monitor equipment (preventive maintenance);
   - Have control of computer-assisted maintenance management (CMMS);
   - Propose solutions to optimize the security and performance of equipment (standby).

3. **Career opportunities**

   - Design office designer;
   - Office Methods Supervisor;
   - Engineering Assistant;
   - Maintenance manager;
   - Quality control and Technical sales agent.
## 4. Organization of teachings

### FIRST SEMESTER

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<td>Physics and Chemistry I</td>
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<td><strong>Transversal Courses 10% (1 UC) 3 credits 45 hours</strong></td>
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<tr>
<td>MIS127</td>
<td>Business creation, Civic and moral Education</td>
<td>25</td>
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## HIRD SEMESTER

### Field: Electrical and Electronic Engineering

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<tr>
<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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<td>MIS231</td>
<td>Mathematics III</td>
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<td>MIS232</td>
<td>Physics and Chemistry III</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<tr>
<td>MIS233</td>
<td>Maintenance process and procedure</td>
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<td>MIS234</td>
<td>Electrical Installation</td>
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<td>MIS235</td>
<td>Production Systems and Maintenance</td>
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<tr>
<td>MIS236</td>
<td>Industrial Networks and Data communication</td>
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<tr>
<td>MIS237</td>
<td>Accounting and labour law</td>
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## FOURTH SEMESTER

### Field: Electrical and Electronic Engineering

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<td>MIS241</td>
<td>Mathematics IV</td>
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<td>MIS242</td>
<td>Computer science II</td>
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<tr>
<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<tr>
<td>MIS243</td>
<td>Organization and Optimization of Maintenance</td>
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<tr>
<td>MIS244</td>
<td>Methods of Fault search</td>
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<td>MIS245</td>
<td>Practical Work: Computer Assisted Maintenance Management (GMAO)</td>
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<tr>
<td>MIS246</td>
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<tr>
<td>MIS247</td>
<td>Economy and business organization</td>
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5. Course content

❖ MIS 111: Mathematics I

➢ Mathematics: 4 credits (60 hours); L, T, SPW
  1. Functions of a real variable.
  2. Circular, hyperbolic, and reciprocal functions.
  5. Taylor Formula and limited developments.
  7. Multiple integrals and their applications to the calculation of area and volume.

❖ MIS 112: Physics and Chemistry: 4 credits (60 hours);

➢ Physics: 3 credits (45 hours); L, T, P, SPW
  1. Kinematics
     ▪ Introduction;
     ▪ Referential system and position vector;
     ▪ Speed and acceleration;
     ▪ Movement in the field of gravity.
  2. Action of forces on a material point
     ▪ Principle of inertia and fundamental principle of the dynamic;
     ▪ The superposition of Forces;
     ▪ The forces of inertia;
     ▪ Friction and friction forces.
  3. Gravitation
     ▪ The force of gravitation;
     ▪ Law of gravitation;
     ▪ Fields of forces.
  4. Work, Power, Energy and Momentum
     ▪ Work;
     ▪ Power;
     ▪ Energy;
     ▪ Momentum.
  5. Action of the forces on a solid body
     ▪ Static;
     ▪ Kinetics of solid bodies.
  6. Fluid Mechanics
     ▪ Fluid and gas at rest;
     ▪ Incompressible liquid.
Chemistry: 2 credits (30 hours); L, T, P, SPW

1. **Nuclear Reactions**
   - Describe the structure of a nucleus (Mass number, atomic number).
   - Characterization of isotopes;
   - Distinguish the different reactivity (spontaneous and non-spontaneous reaction);
   - Establish the equation of a radioactive transformation;
   - Assess the fault of mass and the energy released by a nuclear reaction;
   - Half-life of the radioactive decay;
   - Activity of radioactive isotopes;
   - Radiation protection;
   - Experimental strategy to quantify the radiation received in function of time, distance and materials crossed.

2. **Pure body and mixtures**
   - Distinguish between the different types of mixtures (suspensions, emulsions, alloys, aqueous solutions, smoke and fog);
   - Solubility of a solute in a solvent. Homogenous and heterogeneous Solutions;
   - Density of a solution, Molar concentration, Mass concentration, the molarity, molar fractions and mass concentrations.
   - Distinguish between the molar concentration of the normality;
   - Establish and apply the relations between sizes and molar mass quantities;
   - Describe and explain the operation of a process of liquid-liquid extraction;
   - Establish a balance sheet of overall material and partial to each of the constituents of a liquid-liquid extraction;
   - Articulate and apply the law of perfect gases;
   - Define the total pressure and partial pressures for a gaseous mixture;
   - Difference between absolute and relative pressure;
   - Establish the expression and evaluate the density of a real and a perfect gas;
   - Describe and explain the process of extraction liquid-gas: absorption and desorption;
   - Establish a balance sheet of overall material and partial to each of the components of an extraction liquid-gas.

3. **Chemical reactions**
   - Electronic structure of an atom;
   - Bonding (ionic and covalent bonds);
   - Molecular model of Lewis;
   - Establish an equation of reaction;
   - Establish a molar balance sheet;
   - Standard enthalpy of reaction;
   - Exothermic and endothermic reactions;
4. **Speed of chemical reaction**
   - Set the speed of a reaction by report to a reagent or product;
   - Define the constant speed;
   - Set the order of a reaction by report to a reagent and exploit the equation giving its concentration as a function of time;
   - Define the Time of half-reaction;
   - Identify the factors kinetics: influence of temperature and concentration from follow-up data on the reaction;
   - Explain the role of a catalyst;
   - Operate the curve giving the evolution of a composition of a reagent or a product in the time to identify the order of reaction and evaluate the speed constant and the time to half-reaction.

5. **Reaction in aqueous solution; Acidic, basic and oxido-reduction**
   - Define the specific vocabulary: acid, base according Brönsted, oxidizing, reducer;
   - Oxidation, reduction, torque acido-basic, redox couple;
   - Acido-basic reaction; redox highlighting: exchanges of protons and then of electrons;
   - Establish a link between the powers dissociating, dispersant and solvating of water and its physical properties and molecular structure;
   - Explain the particular case of the water: couples in the water, autoprotolyse, Ke, ampholyte;
   - The reaction acido-basic;
   - Redox reactions.

6. **Organic chemistry**
   - Identify the gross formulas, developed planes, semi-developed topological and isomers of Simple hydrocarbons (alkanes, Cyclanes, alkenes, benzene) and their derivatives (alcohol, carboxylic acid, aldehydes and ketones) and know the appoint;
   - Establish a link between the structure of a molecule of hydrocarbon and its chemical properties;
   - Distinguish between the three types of reactions in organic chemistry: substitution reactions, addition and elimination;
   - Distinguish monomer and polymer;
   - To distinguish the types of reactions of polymerization;
   - Describe the properties of a few industrial polymers.

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**MIS 113: Basics of Electricity and Electrical Circuits**

- **Basics of Electricity and Electrical Circuits 5 credits (75 h); L, T, PW**

  1. **Mathematical tools**
     - Elements of vector calculation (coordinate systems, scalar and product, vector product);
     - Scalar Field, Vector Field, and Field Vector Flow.
2. **Electrostatic field and potential**
   - Electrostatic field;
   - Electrostatic potential;
   - Work of an electrostatic force;
   - Distribution of electrical charges;
   - Electric dipole;
   - Electrostatic field flux - Gauss theorem.

3. **Magnetic induction - Ampère theorem**
   - Lorentz force and magnetic induction (Lorentz force, motion of a charged particle in an uniform electric field and in a uniform magnetic field);
   - Magnetic effects of the currents (Laplace and BIOTSAVART Law, Notion of current density);
   - Magnetic flux induction, Ampère theorem;
   - Magnetic induction created by a circular conductor at a distant point, Magnetic moment concept.

4. **Work of electromagnetic forces**
   - Movement of a circuit in a magnetic field;
   - Notion of inductance (self-inductance, mutual-inductance);
   - Applications.

5. **Electromagnetic induction**
   - Displacement of a conductor in a uniform magnetic induction (Electromagnetic field and induced emf, LENZ law, Notion of generator and motor);
   - FARADAY’S induction law (Self-induction, EMF of self-induction, Establishment and extinction of a current in a RL-circuit);
   - Magnetic energy;
   - Applications.

6. **Capacitances-capacitors**
   - Capacitance of an isolated capacitor (Definition, Capacitance of a conducting sphere);
   - Capacitor (Definition, Load carried by the armatures: case of a spherical capacitor to simplify);
   - Grouping of capacitors;
   - Charging and discharging a capacitor through a resistor.

7. **Single phase alternating current**
   - Reminders on complex numbers;
   - Sinusoidal voltages and currents;
   - Ohm's Law in A C;
   - Dipole in AC;
   - Power in AC systems single phase;
   - Power balance in a circuit - Boucherot's theorem.

8. **Three-phase sources**
   - Balanced sources: sinusoidal voltages and currents;
   - Balanced three-phase loads;
   - Unbalanced loads;
   - Three-phase AC power.
Electrical circuits: 2 credits (30 hours); L, T, SPW

1. Direct current electrical circuit:
   - Electric dipole: definition, current and voltage as oriented quantities, linear dipole, nonlinear dipole, active and passive dipole, static characteristic, convention of the senses and energetic behavior, linear resistance and Ohm's law, nonlinear resistance;
   - Methods of analysis of DC linear circuits: Kirchhoff's laws, Helmholtz’s theorem, mesh currents method, Millman's theorem;
   - Interaction between an active dipole and a variable passive dipole: voltage, current intensity, power, internal losses, efficiency, power adaptation;
   - Simplification of linear circuits: passive linear circuits (equivalence theorems, Kennelly's law), active linear circuits (Thévenin's theorem, Norton's theorem).

2. Periodic phenomena
   - Periodic electrical quantities: period, frequency, continuous value, rms value, active power, oscillation, characteristic ratios of periodic quantities;
   - Sinusoidal electrical oscillations: characteristics (amplitude, pulsation, phase at the origin), average values, superposition, representations (Fresnel vector, complex symbol);
   - Non-sinusoidal electrical oscillations: Fourier series of a non-sinusoidal oscillation, Specific definitions of the non-sinusoidal electrical regime (rms value, active power, apparent power, power factor, reactive power, distortion power, harmonic rate, ripple, etc.), Response of a linear circuit to a non-sinusoidal excitation.

3. Linear electric circuit in fixed frequency sinusoidal mode:
   - Notion of linearity of electric dipoles in sinusoidal excitation;
   - Modeling passive linear elementary dipoles: Ohm's laws, electrical dipole behaviors in sinusoidal excitation;
   - Linear diodes in sinusoidal mode: instantaneous power, active power, apparent power, reactive power, power factor, complex power;
   - Linear circuits in sinusoidal regime: Kirchhoff laws, association of passive elementary dipoles, simplification of passive linear circuits (laws of division of voltage and current, Kerrely's law), resonance, simplification of active linear circuits (power of the source, Thévenin's theorem, Norton's theorem), power adaptation, compensation, analysis methods (Kirchhoff's laws, Helmholtz's theorem, mesh currents method, Millman's theorem);
   - Electrical quadrupole concept: parameters, input and output impedances, wave resistance and apparent power matching, image impedances.

4. Linear electrical circuit and sinusoidal excitation with variable frequency:
   - Expression of parameters as a function of frequency;
- Response of a linear circuit to sinusoidal excitation when the frequency varies;
- Parameter locations and their inversion, transfer function, amplification or gain;
- Diagram of Bode and Nyquist;
- Classic filters.

5. Establishment and interruption of the electric current in a linear circuit:
- Switching of a linear circuit (RL, RC, RLC) subjected to a constant voltage;
- Switching of a linear circuit (RL, RC, RLC) subjected to a sinusoidal voltage.

❖ MIS 114: Electrical machines I

➢ Electrical machines I: 5 credits (75 h); L, T, SPW

A- DC machines
1. Magnetic circuit
2. Constitution and operating principle
3. Modeling and characteristics (construction of Picou ...)
4. Energy balance
5. Reversibility of DC machines
6. Operating as Generators of different types of dc machine
7. Operating as Motors operation of different types of dc machine
8. Scope, selection and maintenance of DC machines

B- Transformers
1. Single phase transformers
   - Constitution and operating principle;
   - Design and diagrams;
   - Characteristics and tests;
   - Energy balance;
   - Operating conditions of machines connected in parallel.
2. Three-phase transformers
   - Constitution and operating principle;
   - Connection of windings, inflation of windings;
   - Phase displacement, characteristic and tests.
3. Special transformers (for measuring)
   - Self-transformer;
   - Voltage transformer;
   - Current transformer.
4. Choice of Transformers and Maintenance
MIS 115: Electronics and Automatism

A - Preliminary considerations and essential relating to industrial automation
1. Introduction
   - Definition and Concept;
   - Functions and objectives;
   - Requirement and complexity.
2. The bases of the Boolean algebra
3. Method of analysis
   - Method of chronograms;
   - Method of Karnaugh.
4. Method of Synthesis
   - Synthesis by wired technology;
   - Grafcet Method (Analysis Grafcet);
   - Synthesis and Technologies.

B - Essential considerations relating to Industrial Automation with programmable technology
1. Definition and Concepts
2. Technology of industrial automation, criteria of choice
3. Industrial Automation API
   - The programmable automation industrial;
   - Hardware and functional organization;
   - Interfacing and extension;
   - Choice of appropriate Automation.
4. Study of an appropriate Automation (according to availability)
   - Architecture and environment;
   - Programming language;
   - Implementation and choice.
5. Practical work in laboratory

Electronics I: 2 credits (30 hours); L, T, SPW
1. Basical notions of semi-conductors
2. The Diodes
   - Current-Voltage characteristics of the an ideal diode;
   - Current-Voltage characteristics of a real diode;
   - Operating limits;
   - A few special diodes;
   - Notions of operating-point;
   - Applications of diodes.
3. Bipolar Transistor
   - Introduction;
   - Structure and operation;
• Characteristics of an NPN;
• Operating Limits;
• Notions of operating-point;
• Dynamic model.

4. **Field Effect Transistor (FET)**
   - Introduction;
   - Current-Voltage characteristics;
   - Different Types of FET;
   - A few circuits of polarization;
   - Applications of FET.

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**MIS 116: Construction Design: 3 credits (45 hours) L, T, SPW**

- **Construction Design: 3 credits (45 hours) L, T, SPW**

  1. **Generalities:**
     - Generalities on drawing;
     - Dimensional dimensioning of a drawing
     - Connections.
  2. **Perspective**
     - Perspective projection of a drawing;
     - Axonometric perspectives.
  3. **Projections**
     - Plan reading.
  4. **Cuts and sections**
     - Different kinds of cuts;
     - Different kinds of sections;
     - Overall drawing;
     - Drawing for definition
  5. **Mechanical connections**
     - Connectors (threaded and unthreaded);
     - Types of links;
     - Characteristics of a link.
  6. **Adjustments**
     - Tolerance ratings;
     - Adjustments.
  7. **The guides**
     - Translation guidance;
     - Rotational guidance;
     - Blocking concept;
     - Concept of lubrication.
MIS 117: Bilingual training

- **English : 1.5 credits (22 hours 30mn))**: L, T, SPW
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication
  4. **Autonomous reading of "writings" of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
     - C.V;
     - Letter of motivation;
     - Letter/memo writing and minutes of a meeting

- **French : 1.5 credits (22 hours 30mn))**: L, T, SPW
  1. **Vocabulaire**
     - Vocabulaire technique et usuel
  2. **Grammaire**
     - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
     - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
     - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
     - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
     - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
     - Des fonctions grammaticales.
  3. **Expression et communication**
     - Compréhension et interaction au cours d’une discussion technique ;
     - Communication orale courante ;
     - Communication orale interactive ;
- De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
- Lecture rapide et compréhension de texte ;
- Synthèse de texte
- De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
- Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
- Expressions figées

**MIS 121: Mathematics II**

- Mathematics II : 4 credits (60 hours); L, T, SPW
  1. Numerical Sequences
  2. Numerical Series
  3. Fourier Series
  4. Laplace transformation
  5. Fourier transformation
  6. Multi-variable functions- Scalar and vectors fields and their applications

**MIS 122: Physics and Computer Science**

- Physics II : 2 credits (30 hours); L, T, P, SPW

B. Oscillations and Waves

  1. Kinematics of oscillating bodies
     - Generalities ;
     - The harmonic oscillator;
     - Superposition of oscillations.
  2. Dynamics of oscillating bodies
     - Free and damped oscillations
     - Forced and coupled oscillations.
  3. Waves
     - Generalities ;
     - Harmonic waves; Groups of waves; Energy transport;
     - The superposition of waves;
     - Reflection, refraction and diffraction of waves;
     - Sound waves and ultrasound.

- Computer Science I : 3 credits (45 hours); L, T, P, SPW

  1. Generalities and vocabulary
     - Concept of information and informatics;
- Resolution of problems by the informatics;
- Typology and computer configuration;
- Fields of application of informatics;

2. **Information representation and processing**
   - Systems of numbers;
   - Representation of Numbers and Characters (coding of information);
   - Boolean logic;
   - Circuits of calculations & memory;
   - Presentation and differences between numerical & non-numerical data.

3. **Structure and operation of a micro-computer**
   - Architectures of a micro-computers;
   - Functional units (Central Unit, Units of entry and exit);
   - Architecture and performance of microprocessors;
   - Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
   - Presentation and roles of programs; their applications.

4. **A Computer : An Interface “Machine (Hardware) - Man (Software)” as solutions to problems**
   - The bios;
   - The systems of applications;
   - Application programs.

5. **Operating systems and examples of operating system**
   - WINDOWS (DOS);
   - Linux: an interesting alternative;

6. **A few examples of applications software**
   - The “Package Microsoft Office” (Word, PowerPoint, Excel);
   - The software of navigation and search engines on the Web.

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**ELT 123: Technics of Measurement and Electronics**

- Measurement techniques: 2 credits (30 hours)
  1. **Chains measurement**
  2. **Sensors**
     - Principles of operation;
     - Choice of the principle and choice of the appropriate sensor;
     - Absolute, relative, differential sensors;
     - Range of measurement and sensitivity,
     - Dynamics sensor.
  3. **Power electronics**
     - Current and voltage supply;
     - Charge amplifier;
     - Sensitivity.
  4. **Signal processing concept (in the data acquisition context)**
     - Different types of signals;

---
- Sampling;
- The fall in the spectrum;
- Digitization;
- Fourier analysis;
- Estimate of the DSP;
- Filtering.

5. Measurement uncertainties
   - Reminders of probabilities notions;
   - Mean, standard deviation, measurement duration;
   - Compositions of errors;
   - Distribution function;
   - Density of probability;
   - Normal and student distribution;
   - Robust estimators;
   - Histograms.

6. Modeling of Measurements
   - Correlation between two random variables;
   - Regression of first and second art;
   - Model of the least squares method;
   - Chi-square method;
   - Periodic effects;
   - Questionable measures;
   - Validation of the model;
   - Quality of the adjustment.

7. Reference quantities and calibrations
   - Reference quantities and transfer standard (for mechanical quantities);
   - Calibration and digital acquisition.

8. Counting in digital acquisition
   - Signals and encoders;
   - Tachymetric signals;
   - Proximity sensors;
   - Tachymetric sensors;
   - Real time;
   - Internal clock.

- Electronics II and Practical Works: 3 credits (45 hours);
  1. Diodes
     - Representation of the Current-voltage characteristics;
     - Half wave rectification;
     - Current-voltage characteristics of the Zener diode;
     - Stabilization of the voltage with the Zener diode.
  2. Transistors
     - Transistor characteristics and network;
     - Basic circuits of transistor amplifier;
Signal generating with RC-circuits;
Memory circuits (flip-flops);
RS, D, JK flip-flops.

3. Thyristors
   • Influence of the trigger voltage on the current;
   • Use of thyristor as DC-voltage switch.

4. Operational amplifiers
   • Basic circuits with operational amplifiers;
   • Coding circuits;
   • 8421-BCD converter / Exess 3;
   • 8421-BCD decoder / 7 segments.

❖ MIS 124: Maintenance

➢ Basis of maintenance: 3 credits (45 hours); L, T, SPW

1. An approach of Industrial Maintenance
   • Definition;
   • Relationship between care and maintenance;
   • The maintenance service.

2. Maintenance strategies
   • Notions of failure;
   • The concepts of maintenance;
   • Maintenance methods;
   • Different levels of Maintenance;
   • The maintenance service.

➢ Maintenance and quality control: 2 credits (30 hours); L, T, SPW

1. Introduction and objectives
2. Definitions relating to the maintenance of biomedical equipment
3. Planning of the maintenance program
   • Inventory concept;
   • Methodologies;
   • Resources.

❖ MIS 125: Power electronics and actuator control

➢ Power electronics and actuator control: 4 credits (60 hours) L, T, SPW

A. Power electronics

1. Introduction
   • General considerations;
   • Definition and objectives;
   • Different types of power conversion.

2. AC / DC converter
- Voltage rectifiers (with diodes, single and three-phase thyristors), internal operation;
- Definition and measurement of input-output quantities;
- Reversibility.

3. **DC / DC converters**
   - Power transistors switching;
   - Study of basic choppers (direct link chopper, chopper, reversible chopper);
   - Isolated switching power supplies;
   - Symmetrical power supplies.

4. **DC / AC converters**
   - Full wave voltage inverters (single-phase, three-phase);
   - UPS in PWM: Principles;
   - Uninterruptible power supply structures;
   - Technologies of storage batteries.

5. **AC / AC converters**
   - Triacs technology;
   - Study of dimmers;
   - Study of cyclo-converters.

6. **Thyristor and Triacs triggering device and circuit**
   - DC and AC priming;
   - Pulse priming.

7. **Electronic controls of machines**
   - Variable speed drive for DC machines;
   - Variable speed drive for AC machines.

B. **Actuator control**

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**MIS 126: CAD in Electrical Engineering**

- **CAD in Electrical Engineering: 4 credits (60 hours) L, T, SPW**
  1. Choice of CAD-Software (s) and practical Information
  2. Presentation and description of the Software (s)
  3. Management of created Data
  4. Study and handling of different modules
  5. Applications to realization of a mini-projects

**MIS 127: Business Creation and Civic and Ethical Education**

- **Entrepreneurship: 1 credit (15 hours) ; L, T, SPW**
  1. Entrepreneur concept
  2. Motivations for starting a business
  3. Ideas research and evaluation
  4. Financing research
5. Choice of legal status

➢ Civic and moral education: 2 credits (30 hours); L, T

  The Concepts
  ▪ The citizen;
  ▪ The Nation;
  ▪ The State;
  ▪ Publics Property and collective’s goods;
  ▪ The freedoms;
  ▪ The public service;
  ▪ Ethics;
  ▪ Ethics, Law and reason;
  ▪ Ethical Problem ;
  ▪ Ethics and management.
  ▪ Civics
  ▪ Deontology
  ▪ Moral consciousness
  ▪ The universal declaration of Human Rights
  ▪ Good governance in public services
  ▪ The importance of civics to the life of the nation
  ▪ Functions of the state and its citizens
  ▪ Deontology, Professional ethics and professionalism
  ▪ Relationship between morality, law and ethics
  ▪ Codes of ethics

loyd 231: Mathematics III

➢ Mathematics III : 4 credits (60 hours); L, T, SPW
  1. Linear systems
  2. Complex numbers
  3. Polynomials functions and rational fractions
  4. Vector spaces and Euclidean vector spaces
  5. Linear applications
  6. Matrices

loyd 232: Physics and chemistry III

➢ Physics III : 3 credits (45 hours); L, T, P, SPW
  1. Thermodynamics
  ▪ Temperature and thermal expansion;
  ▪ Heat and fundamental principle of thermodynamics;
  ▪ Change of state of the ideal gases;
  ▪ Kinetic theory of heat;
• Cyclical process: 2nd fundamental principle of thermodynamics;
• Change of state;
• Propagation of heat.
2. **Electrodynamics and applications**
• Currents and fields;
• Production of magnetic fields;
• Induction phenomenon;
• Alternating current;
• Electromagnetic waves.

➢ **Chemistry: Basics of Quality, Health, Safety and Environment** 2 credits (30 h; L, T, P, SPW)

1. **Management system of a company**
   • Identify the management system of a company using the global standards ISO 9001 and 14001;
   • Use and master the vocabulary of management systems.
2. **Fight against nonconformities and loop of continuous improvement.**
   • Use and master the vocabulary of continuous improvement;
   • Identify the implementation of the continuous improvement loop, regardless of the domain or company involved: ascertain, isolate / contain, analyze causes, treat causes, measure effectiveness;
   • Identify nonconformities, their degree of severity and their consequences in any context;
   • Propose corrective and preventive actions, even improvement, within the limits of its field of intervention;
   • Respect the rules of traceability within the limits of its field of intervention.
3. **Risk analysis and prevention.**
   • Participate in a risk prevention analysis;
   • Participate in a dynamic risk impact analysis;
   • Implement a prevention plan or emergency plan in its area of intervention.
4. **Regulations and technical standards.**
   • Situate its action within the framework of the operational technical standards developed by the IEC TC 65: for example the IEC 61508, IEC 61326, IEC 62443, IEC 62424, IEC 62708 series, etc.
   • Recognize the pictograms, hazard classes and precautionary and prevention statements of the CLP Regulation;
   • Apply the rules of prevention, limitation or prohibition related to the REACH Regulation on substances and their uses, whether in the form of raw materials, in mixtures, or contained in “articles”;
   • Apply ATEX regulations related to the control of risks related to explosive atmospheres;
Comply with the sorting instructions for end-of-life CIRA equipment, issued by the Waste Electrical and Electronic Equipment (WEEE) Directive.

**MIS 233: Maintenance**

- **Basis of maintenance II: 2 credits (30 hours):**
  1. **Organization of a maintenance service**
     - The company's assets;
     - The functions of the maintenance service;
     - Structuring of the maintenance service;
     - The maintenance service.
  2. **Maintenance documentation**
     - General documentation;
     - Strategic documentation.

- **Maintenance and Quality Control II: 3 credits (45 hours):**
  1. **Maintenance Management**
     - Financial management;
     - Staff Management;
     - Operational management;
     - Monitoring and Improvement of performance;
  2. **Implementation of maintenance**
     - Inspection and Preventive Maintenance;
     - Corrective maintenance;
     - Preparation of reports;
     - Quality control and security.
  3. **Conclusions**

**MIS 234: Electrical installations**

- **Electrical installations: 4 credits (60 hours); L, T, SPW**
  1. **General information on the electrical equipment in current use**
     - Characteristics: Voltage, intensity;
     - Power breaking;
     - Functions: sectioning, cut, control, protection.
  2. **Use of electrical appliances in current use**
     - Disconnect Switch, Switch / Circuit Breaker / switch, over current release;
     - The fuses (characteristics) / The thermal relay / differential protection;
     - Indices of protection (IP): Use of measuring devices;
     - The pathophysiological effects of the current on the human body.
3. **Prevention - Compliance with the standards and safety instructions**
   - Legal framework and administrative regulations, applicable standards;
   - Safety requirements for construction, operation and maintenance;
   - Facilities: classes of voltage and different indices.

4. **Some important definitions**
   - Distances of approaches;
   - Work under voltage (approach of consequences);
   - Instructions and responsibilities.

5. **The protection of persons against direct and indirect contact**
   - Definition, various means of protection;
   - Different patterns of binding of earthing, (diagrams TT, IT, TN);
   - Contact Voltage, cut-off time, resistance of the masses, the resistance of the neutral;
   - Contact from the earth, the equipotential bonding;
   - Differential circuit breaker, Principle of operation;
   - Protection against direct contacts: differential devices at high
     
   - Sensitivity;
   - Use of the means of individual protection;
   - Double insulation, circuits of separation, use of the very low voltage;
   - Choice and connections of the electric power tools on the basis of the place of work and the characteristics of the installation;
   - Protection against over current: fuses, thermal magneto-thermical circuit breakers

**MIS 235: Production Systems and Maintenance**

- Production Systems and Maintenance: 4 credits (60 hours): L, T, SPW

**MIS 236: Data Communication and Industrial Networks**

- Data communication: 2 credits (30 hours);
  1. **Parallel I / O**
     - Programmable circuits;
     - Study of a Parallel Interface Adapter (PIA);
     - Inputs / outputs by polling;
     - Masks.
  2. **Asynchronous serial interfaces**
  3. **D / A and A / D conversion.**
     - D / A conversion;
     - A / D conversion;
     - Control of an ADC / DAC card.
  4. **Parallel Interface Timer (PIT)**
  5. **Presentation and application of a microcontroller**
  6. **Data Communications and Local Networks**
- The need of protocols;
- The TCP / IP model;
- The OSI model;
- Topology of Local Networks.

- **Industrial networks: 3 credits (45 hours); L, T, P**

1. **Local Business Network:**
   - Ethernet Network: Functionality, Architecture, Wiring, Operation, OSI Model Analogy;
   - Industrial applications.

2. **Field networks:**
   - Industrial context;
   - Distribution-Decentralization of industrial applications;
   - Communication models: Client - Server;
   - Producer - Consumer;
   - Sensor / Actuator Network: Specificities, Protocol Study, OSI Model Analogy, Standardization, Applications (UPS, I2C, FIP-IO, VAN, CAN, PROFIBUS-PA, ...);
   - control networks: Specificities, Protocol study, Analogy to the OSI model, Normalization, Application cases (PROFIBUS, INTERBUS-S, MODBUS, DEVICE NET, MODLINK, ...);
   - Building control Networks: Specificities, Protocol Study, Analogy to the OSI Model, Standardization, Application Cases (BATIBUS, EIB, EHS, LONWORKS, ...);
   - International standardization.

3. **Interconnection of networks:**
   - Interconnection elements:
     - Physical Segmentation (Repeater, Bridge, Concentrator, Switch),
     - Logical Segmentation (Router, Gateway);
   - Routing and Interconnection Mechanisms and Protocols: Source Routing, Spanning Tree, RIP, EGP;
   - TCP-IP Protocols: IP Addressing, TCP Transport Protocols (Role and Frame Structure), IP Network Protocols (Role and Frame Structure), Address Resolution Protocols (ARP, RARP), Control Protocol (ICMP)).

4. **Perspective and evolution of industrial communication:**
   - Supervision and Control (see remote control of industrial processes).

- **MIS 237: Accounting and Labour Law**

- **Accounting : 1 credits (15 hours); L, T**

1. **General information on cost accounting and business management**
   - Objective;
   - Role;
   - Concept of charge.

2. **Charge analysis**
- Embedded expenses;
- Direct, indirect costs;
- Valuation of stocks.

3. **Full cost method**
   - Purchase cost;
   - Cost of production;
   - Cost price;
   - Calculation of results.

➤ **Labour Law: 1 credit (15 hours); L, T**

**A- First part**
1. The concept of Law;
2. The characters of the Law Rule;
3. Sources of Law (Hierarchical norms);
4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression).

**B- Second part**
1. Sources of Labour Law
2. The different employment contracts (classic contracts and precarious contracts)
3. Execution of the employment contract (salary and salary claim, various professional sanctions)
4. Dismissal and resignation;
5. Resolution of labor disputes

🔗 **MIS 241: Mathematics IV**

➤ **Mathematics IV: 4 credits (60 hours); L, T, SPW**
   1. One-dimensional descriptive statistics;
   2. Linear regression;
   3. Calculation of probabilities;
   4. Laws of probability;
   5. Sampling and
   6. Estimation method;
   7. Chi-square hypothesis test.
MIS 242: Computer Science II

- Computer Science II: 5 credits (75 hours); L, T, P, SPW
  1. Introduction
  2. Fundamental elements
     - Problem and algorithm;
     - Program and programming language;
     - From the problem to the computer solution;
     - The paradigms of programming;
  3. Concepts of programming in C++
     - Presentation and description of the programming language;
     - Structuring a program;
     - Descriptions of Data, Actions;
     - Programming style.

MIS 243: Organization and optimization of maintenance

- Organization and optimization of maintenance: 4 credits (60 hours); L, T, P
  1. Objectives of a maintenance plan
     - The full cost of maintenance and availability
     - The maintenance process
     - Choose your maintenance strategy
  2. Priorities
     - Determine the criticality of equipment
     - Apply the ABC method
  3. Links with the maintenance board
     - Key indicators
     - Formatting and communication
  4. Simplified RCM method
     - Application of maintenance strategy
  5. Levels of maintenance tasks
     - Definition and choice of levels
     - How to privilege and value level 1
  6. Information circuits, the basis of optimization
     - Reference documents of the maintenance plan
     - Planning
     - Recordings
  7. Case study in the form of mini-projects:
     - Identification of the pre-diagnosis area;
     - Information and necessary documents;
     - Development of a maintenance plan for a production unit
MIS 244: Fault diagnosis: 4 credits (60 h); L, T, SPW

- Fault diagnosis: 4 credits (60 h); L, T, SPW
  1. Reminders about maintenance in general
     - Types of maintenance (curative, preventive and predictive);
     - Levels of maintenance;
     - Organization of maintenance.
  2. Communication concept
     - Diagram of the communication;
     - Barriers in communication (distortion and loss of information);
     - Why intervene?
     - Report and report.
  3. Troubleshooting Methodology
     - Specification of the problem;
     - Careful examination of the real functioning;
     - User survey;
     - Accurate identification of defects;
     - Location and extent of the failure;
     - Formulation of the specification;
     - Decomposition of a block system;
     - Definition of blocks;
     - Look for bad blocks in a system;
     - Analytic and synthetic approach;
     - search differences and changes;
     - Formulation of possible causes;
     - Test the most likely cause;
     - Search for the defective block;
     - Repair, control and testing

MIS 245: Practical Work: Electrical Machines II

- Practical Work: Electrical Machines II: 4 credits (60 hours); P
  1. Alternators;
  2. Coupling of alternators to the electrical network;
  3. Synchronous motors;

MIS 246: Professional internship

- Professional internship: 6 credits (90 hours); P, SPW
  1. Arrival and integration in the companies
  2. Work in a company
  3. Keeping the trainee journal
4. Choice of the working theme in collaboration with the professional supervisor and the academic supervisor
5. Development of the research framework
6. Resources to exploit
7. Organization of work
8. Writing the report
9. Presentation of the report before a jury

**MIS 247: Economy and business organization**

- **Economy and business organization:** 3 credits (45 hours); L, T, SPW

1. **Concepts of General Economics**
   - Introduction;
   - Consumption and production;
   - Income training;
   - Money and Credit;
   - Prices;
   - The notion of growth and development.

2. **The Company**
   - Introduction;
   - Typology of companies;
   - Structure and organization of the company;
   - Business and Ethics;
   - How to undertake (Create, Decide, and Manage).

3. **The place of the company in the economic environment**
   - Concept of the business environment;
   - Inter and extra-company relations;
   - Commercial activity;
   - Concept of Strategy.

4. **Productive activity**
   - Production policies and processes;
   - Trade policies;
   - Logistics.

5. **The Concept of Management in the Company**
   - Activity and financial resources;
   - Planning and management of human resources;
   - Planning and management of material resources.

6. **Information and Communication in the Company**
   - Role of information and communication;
   - Collection and organization of information;
   - Strategic diagnosis;
   - Decision system.
Field: ELECTRICAL AND ELECTRONIC ENGINEERING

Specialty: MAINTENANCE OF BIOMEDICAL EQUIPMENTS
1. **Objective of the training**

The objective of this training is to train installation and maintenance technicians of biomedical equipment in order to integrate permanent technological innovations and to meet the high demand for technicians specializing in the maintenance of biomedical devices in hospitals and other medical and biomedical health care and industries.

2. **Research skills**
   - **Generic skills**
     - Work independently and in team collaboration;
     - Analyze, synthesize professional documents (French, English);
     - Orally and written communication (French, English);
     - Participate in (other) lead project management process;
     - Know and exploit professional and institutional networks of electricity sectors.
   - **Specific skills**
     - Diagnose a breakdown of medical and biomedical equipment;
     - Maintain and repair medical and biomedical equipment;
     - Plan preventive maintenance interventions for equipment;
     - Write biomedical maintenance protocols;
     - Train and advice users on operations of biomedical devices;
     - Team working;
     - Evaluate the risks related to the use of the equipment and warn in case of improper use.

3. **Career opportunities**
   - Clinical and medico-technical services for maintenance and training;
   - Providers for planning and external interventions;
   - Technical services for maintenance and commissioning;
   - Logistical and general services for management and organization
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
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<tr>
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<th>Number of hours</th>
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<td>Physics and Chemistry I</td>
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<td>MBE113</td>
<td>Basics of Electricity and Electrical circuit</td>
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<td>MBE115</td>
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<td>MBE116</td>
<td>Construction Design</td>
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- **SECOND SEMESTER**

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<td>MBE123</td>
<td>Measurement Technology and Electronics</td>
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<td>MBE124</td>
<td>Maintenance</td>
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<td>MBE125</td>
<td>Power Electronics and actuator control</td>
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<td>MBE126</td>
<td>CAD in Electrical Engineering</td>
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<td>MBE127</td>
<td>Business creation, Civic and ethical Education</td>
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### THIRD SEMESTER

**Field: Electrical and Electronic Engineering**

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<td>Basics of Physiology, Anatomy and Biology</td>
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<td>MBE235</td>
<td>Medical imaging technics</td>
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### FOURTH SEMESTER

**Field: Electrical and Electronic Engineering**

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5. Course content

❖ MBE 111: Mathematics I

➢ Mathematics : 4 credits (60 hours); L, T, SPW
  1. Functions of a real variable.
  2. Circular, hyperbolic, and reciprocal functions.
  5. Taylor Formula and limited developments.
  7. Multiple integrals and their applications to the calculation of area and volume.

❖ MBE 112: Physics and Chemistry

➢ Physics : 3 credits (45 hours); L, T, P, SPW
  1. Kinematics
     ▪ Introduction;
     ▪ Referential system and position vector;
     ▪ Speed and acceleration;
     ▪ Movement in the field of gravity.
  2. Action of forces on a material point
     ▪ Principle of inertia and fundamental principle of the dynamic;
     ▪ The superposition of Forces;
     ▪ The forces of inertia;
     ▪ Friction and friction forces.
  3. Gravitation
     ▪ The force of gravitation;
     ▪ Law of gravitation;
     ▪ Fields of forces.
  4. Work, Power, Energy and Momentum
     ▪ Work;
     ▪ Power;
     ▪ Energy;
     ▪ Momentum.
  5. Action of the forces on a solid body
     ▪ Static;
     ▪ Kinetics of solid bodies.
  6. Fluid Mechanics
     ▪ Fluid and gas at rest;
     ▪ Incompressible liquid.
Chemistry : 2 credits (30 hours); L, T, P, SPW

1. **Nuclear Reactions**
   - Describe the structure of a nucleus (Mass number, atomic number).
   - Characterization of isotopes;
   - Distinguish the different reactivity (spontaneous and non-spontaneous reaction);
   - Establish the equation of a radioactive transformation;
   - Assess the fault of mass and the energy released by a nuclear reaction;
   - Half-life of the radioactive decay;
   - Activity of radioactive isotopes;
   - Radiation protection;
   - Experimental strategy to quantify the radiation received in function of time, distance and materials crossed.

2. **Pure body and mixtures**
   - Distinguish between the different types of mixtures (suspensions, emulsions, alloys, aqueous solutions, smoke and fog);
   - Solubility of a solute in a solvent. Homogenous and heterogeneous Solutions;
   - Density of a solution, Molar concentration, Mass concentration, the molarity, molar fractions and mass concentrations.
   - Distinguish between the molar concentration of the normality;
   - Establish and apply the relations between sizes and molar mass quantities;
   - Describe and explain the operation of a process of liquid-liquid extraction;
   - Establish a balance sheet of overall material and partial to each of the constituents of a liquid-liquid extraction;
   - Articulate and apply the law of perfect gases;
   - Define the total pressure and partial pressures for a gaseous mixture;
   - Difference between absolute and relative pressure;
   - Establish the expression and evaluate the density of a real and a perfect gas;
   - Describe and explain the process of extraction liquid-gas: absorption and desorption;
   - Establish a balance sheet of overall material and partial to each of the components of an extraction liquid-gas.

3. **Chemical reactions**
   - Electronic structure of an atom;
   - Bonding (ionic and covalent bonds);
   - Molecular model of Lewis;
   - Establish an equation of reaction;
   - Establish a molar balance sheet;
   - Standard enthalpy of reaction;
   - Exothermic and endothermic reactions;
4. **Speed of chemical reaction**
   - Set the speed of a reaction by report to a reagent or product;
   - Define the constant speed;
   - Set the order of a reaction by report to a reagent and exploit the equation giving its concentration as a function of time;
   - Define the Time of half-reaction;
   - Identify the factors kinetics: influence of temperature and concentration from follow-up data on the reaction;
   - Explain the role of a catalyst;
   - Operate the curve giving the evolution of a composition of a reagent or a product in the time to identify the order of reaction and evaluate the speed constant and the time to half-reaction.

5. **Reaction in aqueous solution; Acidic, basic and oxido-reduction**
   - Define the specific vocabulary: acid, base according Brönsted, oxidizing, reducer;
   - Oxidation, reduction, torque acido-basic, redox couple;
   - Acido-basic reaction; redox highlighting: exchanges of protons and then of electrons;
   - Establish a link between the powers dissociating, dispersant and solvating of water and its physical properties and molecular structure;
   - Explain the particular case of the water: couples in the water, autoprotolyse, Ke, ampholyte;
   - The reactionsacido-basic;
   - Redox reactions.

6. **Organic chemistry**
   - Identify the gross formulas, developed planes, semi-developed topological and isomers of Simple hydrocarbons (alkanes, Cyclanes, alkenes, benzene) and their derivatives (alcohol, carboxylic acid, aldehydes and ketones) and know the appoint;
   - Establish a link between the structure of a molecule of hydrocarbon and its chemical properties;
   - Distinguish between the three types of reactions in organic chemistry: substitution reactions, addition and elimination;
   - Distinguish monomer and polymer;
   - To distinguish the types of reactions of polymerization;
   - Describe the properties of a few industrial polymers.

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**MBE 113: Basics of Electricity and Electrical Circuits**

- **Basics of Electricity and Electrical Circuits 5 credits (75 h); L, T, PW**
  1. **Mathematical tools**
     - Elements of vector calculation (coordinate systems, scalar and product, vector product);
     - Scalar Field, Vector Field, and Field Vector Flow.
2. **Electrostatic field and potential**
   - Electrostatic field;
   - Electrostatic potential;
   - Work of an electrostatic force;
   - Distribution of electrical charges;
   - Electric dipole;
   - Electrostatic field flux - Gauss theorem.

3. **Magnetic induction - Ampère theorem**
   - Lorentz force and magnetic induction (Lorentz force, motion of a charged particle in an uniform electric field and in a uniform magnetic field);
   - Magnetic effects of the currents (Laplace and BIOTSAVART Law, Notion of current density);
   - Magnetic flux induction, Ampère theorem;
   - Magnetic induction created by a circular conductor at a distant point, Magnetic moment concept.

4. **Work of electromagnetic forces**
   - Movement of a circuit in a magnetic field;
   - Notion of inductance (self-inductance, mutual-inductance);
   - Applications.

5. **Electromagnetic induction**
   - Displacement of a conductor in a uniform magnetic induction (Electromagnetic field and induced emf, LENZ law, Notion of generator and motor);
   - FARADAY'S induction law (Self-induction, EMF of self-induction, Establishment and extinction of a current in a RL-circuit);
   - Magnetic energy;
   - Applications.

6. **Capacitances-capacitors**
   - Capacitance of an isolated capacitor (Definition, Capacitance of a conducting sphere);
   - Capacitor (Definition, Load carried by the armatures: case of a spherical capacitor to simplify);
   - Grouping of capacitors;
   - Charging and discharging a capacitor through a resistor.

7. **Single phase alternating current**
   - Reminders on complex numbers;
   - Sinusoidal voltages and currents;
   - Ohm's Law in AC;
   - Dipole in AC;
   - Power in AC systems single phase;
   - Power balance in a circuit - Boucherot's theorem.

8. **Three-phase sources**
   - Balanced sources: sinusoidal voltages and currents;
   - Balanced three-phase loads;
• Unbalanced loads;
• Three-phase AC power

➢ Electrical circuits : 2 credits (30 hours); L, T, SPW

1. Direct current electrical circuit:
   • Electric dipole: definition, current and voltage as oriented quantities, linear dipole, nonlinear dipole, active and passive dipole, static characteristic, convention of the senses and energetic behavior, linear resistance and Ohm's law, nonlinear resistance;
   • Methods of analysis of DC linear circuits: Kirchhoff's laws, Helmholtz's theorem, mesh currents method, Millman's theorem;
   • Interaction between an active dipole and a variable passive dipole: voltage, current intensity, power, internal losses, efficiency, power adaptation;
   • Simplification of linear circuits: passive linear circuits (equivalence theorems, Kennely's law), active linear circuits (Thévenin's theorem, Norton's theorem).

2. Periodic phenomena
   • Periodic electrical quantities: period, frequency, continuous value, rms value, active power, oscillation, characteristic ratios of periodic quantities;
   • Sinusoidal electrical oscillations: characteristics (amplitude, pulsation, phase at the origin), average values, superposition, representations (Fresnel vector, complex symbol);
   • Non-sinusoidal electrical oscillations: Fourier series of a non-sinusoidal oscillation, Specific definitions of the non-sinusoidal electrical regime (rms value, active power, apparent power, power factor, reactive power, distortion power, harmonic rate, ripple, etc.), Response of a linear circuit to a non-sinusoidal excitation.

3. Linear electric circuit in fixed frequency sinusoidal mode:
   • Notion of linearity of electric dipoles in sinusoidal excitation;
   • Modeling passive linear elementary dipoles: Ohm's laws, electrical dipole behaviors in sinusoidal excitation;
   • Linear diodes in sinusoidal mode: instantaneous power, active power, apparent power, power factor, complex power;
   • Linear circuits in sinusoidal regime: Kirchhoff laws, association of passive elementary dipoles, simplification of passive linear circuits (laws of division of voltage and current, Kerrely's law), resonance, simplification of active linear circuits (power of the source, Thévenin's theorem, Norton's theorem), power adaptation, compensation, analysis methods (Kirchhoff's laws, Helmholtz's theorem, mesh currents method, Millman's theorem);
   • Electrical quadrupole concept: parameters, input and output impedances, wave resistance and apparent power matching, image impedances.
4. **Linear electrical circuit and sinusoidal excitation with variable frequency:**
   - Expression of parameters as a function of frequency;
   - Response of a linear circuit to sinusoidal excitation when the frequency varies;
   - Parameter locations and their inversion, transfer function, amplification or gain;
   - Diagram of Bode and Nyquist;
   - Classic filters.

5. **Establishment and interruption of the electric current in a linear circuit:**
   - Switching of a linear circuit (RL, RC, RLC) subjected to a constant voltage;
   - Switching of a linear circuit (RL, RC, RLC) subjected to a sinusoidal voltage.

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**MBE 114: Electrical machines I**

- **Electrical machines I: 5 credits (75 h); L, T, SPW**
  - **A- DC machines**
    1. Magnetic circuit
    2. Constitution and operating principle
    3. Modeling and characteristics (construction of Picou ...)
    4. Energy balance
    5. Reversibility of DC machines
    6. Operating as Generators of different types of dc machine
    7. Operating as Motors operation of different types of dc machine
    8. Scope, selection and maintenance of DC machines
  - **B- Transformers**
    1. **Single phase transformers**
       - Constitution and operating principle;
       - Design and diagrams;
       - Characteristics and tests;
       - Energy balance;
       - Operating conditions of machines connected in parallel.
    2. **Three-phase transformers**
       - Constitution and operating principle;
       - Connection of windings, inflation of windings;
       - Phase displacement, characteristic and tests.
    3. **Special transformers (for measuring)**
       - Self-transformer;
       - Voltage transformer;
       - Current transformer.
    4. **Choice of Transformers and Maintenance**
Automatism ant Practical Work: 3 credits (45 hours); L, T, P

A- Preliminary considerations and essential relating to industrial automation
1. Introduction
   - Definition and Concept;
   - Functions and objectives;
   - Requirement and complexity.
2. The bases of the Boolean algebra
3. Method of analysis
   - Method of chronograms;
   - Method of Karnaugh.
4. Method of Synthesis
   - Synthesis by wired technology;
   - Grafcet Method (Analysis Grafcet);
   - Synthesis and Technologies.

B- Essential considerations relating to Industrial Automation with programmable technology
5. Definition and Concepts
6. Technology of industrial automation, criteria of choice
7. Industrial Automation API
   - The programmable automation industrial;
   - Hardware and functional organization;
   - Interfacing and extension;
   - Choice of appropriate Automation.
8. Study of an appropriate Automation (according to availability)
   - Architecture and environment;
   - Programming language;
   - Implementation and choice.
9. Practical work in laboratory

Electronics I : 2 credits (30 hours); L, T, SPW

1. Basical notions of semi-conductors
2. The Diodes
   - Current-Voltage characteristics of the an ideal diode;
   - Current-Voltage characteristics of a real diode;
   - Operating limits;
   - A few special diodes;
   - Notions of operating-point;
   - Applications of diodes.
3. Bipolar Transistor
   - Introduction;
   - Structure and operation;
- Characteristics of an NPN;
- Operating Limits;
- Notions of operating-point;
- Dynamic model.

4. Field Effect Transistor (FET)
   - Introduction;
   - Current-Voltage characteristics;
   - Different Types of FET;
   - A few circuits of polarization;
   - Applications of FET.

❖ MBE 116: Construction Design

➢ Construction Design: 3 credits (45 hours) L, T, SPW

1. Generalities:
   - Generalities on drawing;
   - Dimensional dimensioning of a drawing
   - Connections.

2. Perspective
   - Perspective projection of a drawing;
   - Axonometric perspectives.

3. Projections
   - Plan reading.

4. Cuts and sections
   - Different kinds of cuts;
   - Different kinds of sections;
   - Overall drawing;
   - Drawing for definition

5. Mechanical connections
   - Connectors (threaded and unthreaded);
   - Types of links;
   - Characteristics of a link.

6. Adjustments
   - Tolerance ratings;
   - Adjustments.

7. The guides
   - Translation guidance;
   - Rotational guidance;
   - Blocking concept;
   - Concept of lubrication.
ME 117: Bilingual training

**English : 1.5 credits (22 hours 30mn))**; L, T, SPW

1. **Vocabulary**
   - Technical and usual vocabulary of the specialty

2. **Grammar**

3. **Bilingual expression**
   - Understanding in interaction in Technical Discussions
   - Continuous oral communication: Show, explain, develop, summarize, account, comment;
   - Interactions oral communication

4. **Autonomous reading of "writings" of all levels**
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
   - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. **Write clear, detailed texts**
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

**French : 1.5 credits (22 hours 30mn))**; L, T, SPW

1. **Vocabulaire**
   - Vocabulaire technique visuel

2. **Grammaire**
   - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   - Des fonctions grammaticales.

3. **Expression et communication**
   - Compréhension et interaction au cours d’une discussion technique ;
   - Communication orale courante ;
   - Communication orale interactive ;
   - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
- Lecture rapide et compréhension de texte ;
- Synthèse de texte
- De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
- Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
- Expressions figées

❖ MBE 121: Mathematics II

➢ Mathematics II : 4 credits (60 hours); L, T, SPW

1. Numerical Sequences
2. Numerical Series
3. Fourier Series
4. Laplace transformation
5. Fourier transformation
6. Multi-variable functions- Scalar and vectors fields and their applications

❖ MBE 122: Physics and Computer Science

➢ Physics II : 2 credits (30 hours); L, T, P, SPW

A. Oscillations and Waves

1. Kinematics of oscillating bodies
   - Generalities ;
   - The harmonic oscillator;
   - Superposition of oscillations.
2. Dynamics of oscillating bodies
   - Free and damped oscillations
   - Forced and coupled oscillations.
3. Waves
   - Generalities :
   - Harmonic waves; Groups of waves; Energy transport;
   - The superposition of waves;
   - Reflection, refraction and diffraction of waves;
   - Sound waves and ultrasound.

➢ Computer Science I : 3 credits (45 hours); L, T, P, SPW

1. Generalities and vocabulary
   - Concept of information and informatics;
2. **Information representation and processing**
   - Systems of numbers;
   - Representation of Numbers and Characters (coding of information);
   - Boolean logic;
   - Circuits of calculations & memory;
   - Presentation and differences between numerical & non-numerical data.

3. **Structure and operation of a micro-computer**
   - Architectures of a micro-computers;
   - Functional units (Central Unit, Units of entry and exit);
   - Architecture and performance of microprocessors;
   - Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
   - Presentation and roles of programs; their applications.

4. **A Computer : An Interface “Machine (Hardware) - Man (Software)” as solutions to problems**
   - The bios;
   - The systems of applications;
   - Application programs.

5. **Operating systems and examples of operating system**
   - WINDOWS (DOS);
   - Linux: an interesting alternative;

6. **A few examples of applications software**
   - The "Package Microsoft Office" (Word, PowerPoint, Excel);
   - The software of navigation and search engines on the Web.

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**MBE 123: Technics of Measurement and Electronics**

- **Measurement techniques**: 2 credits (30 hours)
  1. **Chains measurement**
  2. **Sensors**
     - Principles of operation;
     - Choice of the principle and choice of the appropriate sensor;
     - Absolute, relative, differential sensors;
     - Range of measurement and sensitivity,
     - Dynamics sensor.
  3. **Power electronics**
     - Current and voltage supply;
     - Charge amplifier;
     - Sensitivity.
  4. **Signal processing concept (in the data acquisition context)**
- Different types of signals;
- Sampling;
- The fall in the spectrum;
- Digitization;
- Fourier analysis;
- Estimate of the DSP;
- Filtering.

5. Measurement uncertainties
- Reminders of probabilities notions;
- Mean, standard deviation, measurement duration;
- Compositions of errors;
- Distribution function;
- Density of probability;
- Normal and student distribution;
- Robust estimators;
- Histograms.

6. Modeling of Measurements
- Correlation between two random variables;
- Regression of first and second art;
- Model of the least squares method;
- Chi-square method;
- Periodic effects;
- Questionable measures;
- Validation of the model;
- Quality of the adjustment.

7. Reference quantities and calibrations
- Reference quantities and transfer standard (for mechanical quantities);
- Calibration and digital acquisition.

8. Counting in digital acquisition
- Signals and encoders;
- Tachymetric signals;
- Proximity sensors;
- Tachymetric sensors;
- Real time;
- Internal clock.

➢ Electronics II and Practical Works: 3 credits (45 hours):

1. Diodes
   - Representation of the Current-voltage characteristics;
   - Half wave rectification;
   - Current-voltage characteristics of the Zener diode;
   - Stabilization of the voltage with the Zener diode.

2. Transistors
   - Transistor characteristics and network;
   - Basic circuits of transistor amplifier;
- Signal generating with RC-circuits;
- Memory circuits (flip-flops);
- RS, D, JK flip-flops.

3. Thyristors
   - Influence of the trigger voltage on the current;
   - Use of thyristor as DC-voltage switch.

4. Operational amplifiers
   - Basic circuits with operational amplifiers;
   - Coding circuits;
   - 8421-BCD converter / Exess 3;
   - 8421-BCD decoder / 7 segments.

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**MBE 124: Maintenance**

- **Basis of maintenance**: 3 credits (45 hours); L, T, SPW
  1. **An approach of Industrial Maintenance**
     - Definition;
     - Relationship between care and maintenance;
     - The maintenance service.
  2. **Maintenance strategies**
     - Notions of failure;
     - The concepts of maintenance;
     - Maintenance methods;
     - Different levels of Maintenance;
     - The maintenance service.

- **Maintenance and quality control**: 2 credits (30 hours); L, T, SPW
  1. **Introduction and objectives**
  2. **Definitions relating to the maintenance of biomedical equipment**
  3. **Planning of the maintenance program**
     - Inventory concept;
     - Methodologies;
     - Resources.

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**MBE 125: Power electronics and actuator control**

- **Power electronics and actuator control**: 4 credits (60 hours) L, T, SPW

  **A. Power electronics**
  1. **Introduction**
     - General considerations;
     - Definition and objectives;
     - Different types of power conversion.
  2. **AC / DC converter**
     - Voltage rectifiers (with diodes, single and three-phase thyristors), internal operation;
- Definition and measurement of input-output quantities;
- Reversibility.

3. **DC / DC converters**
   - Power transistors switching;
   - Study of basic choppers (direct link chopper, chopper, reversible chopper);
   - Isolated switching power supplies;
   - Symmetrical power supplies.

4. **DC / AC converters**
   - Full wave voltage inverters (single-phase, three-phase);
   - UPS in PWM: Principles;
   - Uninterruptible power supply structures;
   - Technologies of storage batteries.

5. **AC / AC converters**
   - Triacs technology;
   - Study of dimmers;
   - Study of cyclo-converters.

6. **Thyristor and Triacs triggering device and circuit**
   - DC and AC priming;
   - Pulse priming.

7. **Electronic controls of machines**
   - Variable speed drive for DC machines;
   - Variable speed drive for AC machines.

**B. Actuator control**

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**MBE 126: CAD in Electrical Engineering**

- **CAD in Electrical Engineering**: 4 credits (60 hours) L, T, SPW
  1. Choice of CAD-Software (s) and practical Information
  2. Presentation and description of the Software (s)
  3. Management of created Data
  4. Study and handling of different modules
  5. Applications to realization of a mini-projects

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**MBE 127: Business Creation and Civic and Ethical Education**

- **Entrepreneurship**: 1 credit (15 hours) ; L, T, SPW
  1. Entrepreneur concept
  2. Motivations for starting a business
  3. Ideas research and evaluation
  4. Financing research
  5. Choice of legal status
Civic and moral education: 2 credits (30 hours); L, T

The Concepts
- The citizen;
- The Nation;
- The State;
- Publics Property and collective’s goods;
- The freedoms;
- The public service;
- Ethics;
- Ethics, Law and reason;
- Ethical Problem;
- Ethics and management.
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontlogy, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics

MBE 231: Mathematics III

Mathematics III : 4 credits (60 hours); L, T, SPW
1. Linear systems
2. Complex numbers
3. Polynomials functions and rational fractions
4. Vector spaces and Euclidean vector spaces
5. Linear applications
6. Matrices

MBE 232: Physics and chemistry III

Physics III : 3 credits (45 hours); L, T, P,SPW
1. Thermodynamics
   - Temperature and thermal expansion;
   - Heat and fundamental principle of thermodynamics;
   - Change of state of the ideal gases;
   - Kinetic theory of heat;
   - Cyclical process: 2nd fundamental principle of thermodynamics;
   - Change of state;
   - Propagation of heat.
2. Electrodynamics and applications
   - Currents and fields;
   - Production of magnetic fields;
   - Induction phenomenon;
   - Alternating current;
   - Electromagnetic waves.

➢ Chemistry: Basics of Quality, Health, Safety and Environment 2 credits (30 h; L, T, P, SPW)

1. Management system of a company
   - Identify the management system of a company using the global standards ISO 9001 and 14001;
   - Use and master the vocabulary of management systems.

2. Fight against nonconformities and loop of continuous improvement.
   - Use and master the vocabulary of continuous improvement;
   - Identify the implementation of the continuous improvement loop, regardless of the domain or company involved: ascertain, isolate / contain, analyze causes, treat causes, measure effectiveness;
   - Identify nonconformities, their degree of severity and their consequences in any context;
   - Propose corrective and preventive actions, even improvement, within the limits of its field of intervention;
   - Respect the rules of traceability within the limits of its field of intervention.

   - Participate in a risk prevention analysis;
   - Participate in a dynamic risk impact analysis;
   - Implement a prevention plan or emergency plan in its area of intervention.

4. Regulations and technical standards.
   - Situate its action within the framework of the operational technical standards developed by the IEC TC 65: for example the IEC 61508, IEC 61326, IEC 62443, IEC 62424, IEC 62708 series, etc.
   - Recognize the pictograms, hazard classes and precautionary and prevention statements of the CLP Regulation;
   - Apply the rules of prevention, limitation or prohibition related to the REACH Regulation on substances and their uses, whether in the form of raw materials, in mixtures, or contained in "articles";
   - Apply ATEX regulations related to the control of risks related to explosive atmospheres;
   - Comply with the sorting instructions for end-of-life CiRA equipment, issued by the Waste Electrical and Electronic Equipment (WEEE) Directive.
MBE 233: Maintenance

- Basis of maintenance II: 2 credits (30 hours);
  1. Organization of a maintenance service
     - The company's assets;
     - The functions of the maintenance service;
     - Structuring of the maintenance service;
     - The maintenance service.
  2. Maintenance documentation
     - General documentation;
     - Strategic documentation.

- Maintenance and Quality Control II: 3 credits (45 hours);
  1. Maintenance Management
     - Financial management;
     - Staff Management;
     - Operational management;
     - Monitoring and Improvement of performance;
  2. Implementation of maintenance
     - Inspection and Preventive Maintenance;
     - Corrective maintenance;
     - Preparation of reports;
     - Quality control and security.
  3. Conclusions

MBE 234: Basics elements of physiology and anatomy

- Basics elements of physiology and anatomy: 4 credits, (60 hours); L, T, SPW

  A. Musculoskeletal System
    1. Skeletal tissues:
       - Functions;
       - Cartilage;
       - Bones.
    2. Skeleton: Types of bones; Axial skeleton; Appendicular skeleton.
    3. The Joints
       - Definition and classification;
       - Description of a diarthrose; movements.
    4. Muscle tissue
       - Properties, functions; Types of muscle; striated muscles skeletal.
    5. The muscles
       - Types of muscles;
       - Description of a few muscles.

  B. The cardio-vascular system:
1. The Heart: Anatomy; physiology.
2. The blood vessels:
   - General characteristics;
   - Physiology of circulation;
   - Anatomy of the vascular system.
3. The lymphatic system
   - The lymph vessels;
   - Lymph nodes;
   - Other lymphoid organs.

B- Respiratory System
1. Introduction
   - Functions of the respiratory system;
   - Respiratory processes.
2. Functional Anatomy
   - Nose, pharynx, larynx, trachea;
   - Bronchial tree;
   - Alveolar membrane-capillary barrier;
   - Lungs, pleura and pulmonary vasculature.
3. Respiratory mechanisms
   - Pulmonary pressures and the act of Boyle-Mariotte;
   - Lung ventilation: inspiration / expiration; cycle factors influencing the pulmonary ventilation; respiratory volumes and functional tests.
4. Gaseous exchanges
   - The fundamental properties of gas;
   - Composition of the alveolar gas;
   - External breathing;
   - Internal breathing;
   - Ventilation-Infusion Coupling;
5. Transport of respiratory gases in the blood
   - Transport of O2;
   - Transport of CO2;
   - Conclusion.
6. Regulation of ventilation

C. Urinary system
1. Renal anatomy
   - Externalanatomy;
   - Internalanatomy;
   - Nephron;
   - Vascularization and innervation;
   - Juxta-glomerular device.
2. **Renal physiology**
   - Training of the urine;
   - Characteristics of the urine;
   - Kidney functions.

3. **Urinary canals**
   - The ureters; bladder; Urethra; Urination.

D. **Digestive System**

1. **Generalities**
   - The control of food intake;
   - Digestive processes;
   - General organization;
   - General histology of the digestive tube;
   - Regulation;
   - Peritoneum;
   - Splanchnic circulation.

2. **Systematic study**
   - Oral cavity;
   - Esophagus, swallowing, stomach;
   - Pancreas, liver and bile;
   - Small intestine;
   - Summary panorama of the digestion of food;
   - Large intestine, defecation.

E. **Sense organs**

1. **Eye and lacrimal tracks**
   - Annexes;
   - Eye-ball and optical channels.

2. **Ear**
   - External, middle and inner ear

❖ **MBE 235: Medical Imaging Techniques**

➢ **Medical Imaging Techniques: 4 credits (60 hours): L, P, SPW**

1. **Introduction and Problematics**;
2. **Medical imaging techniques**;
   - X-ray imaging;
   - Imaging by electromagnetic waves;
   - Imaging by Sound waves.
3. **Case studies**
   - Radiography;
   - Ultrasound;
   - The scanner;
   - Others systems.
MBE 236: Data Communication and Industrial Networks

- Data communication: 2 credits (30 hours);
  1. Parallel I / O
     - Programmable circuits;
     - Study of a Parallel Interface Adapter (PIA);
     - Inputs / outputs by polling;
     - Masks.
  2. Asynchronous serial interfaces
     - D / A conversion;
     - A / D conversion;
     - Control of an ADC / DAC card.
  4. Parallel Interface Timer (PIT)
  5. Presentation and application of a microcontroller
  6. Data Communications and Local Networks
     - The need of protocols;
     - The TCP / IP model;
     - The OSI model;
     - Topology of Local Networks.

- Industrial networks: 3 credits (45 hours); L, T, P
  1. Local Business Network:
     - Ethernet Network: Functionality, Architecture, Wiring, Operation, OSI Model Analogy;
     - Industrial applications.
  2. Field networks:
     - Industrial context;
     - Distribution-Decentralization of industrial applications;
     - Communication models: Client - Server;
     - Producer - Consumer;
     - Sensor / Actuator Network: Specificities, Protocol Study, OSI Model Analogy, Standardization, Applications (UPS, I2C, FIP-IO, VAN, CAN, PROFIBUS-PA, ...);
     - control networks: Specificities, Protocol study, Analogy to the OSI model, Normalization, Application cases (PROFIBUS, INTERBUS-S, MODBUS, DEVICE NET, MODLINK, ...);
     - Building control Networks: Specificities, Protocol Study, Analogy to the OSI Model, Standardization, Application Cases (BATIBUS, EIB, EHS, LONWORKS, ...);
     - International standardization.
  3. Interconnection of networks:
     - Interconnection elements:
       - Physical Segmentation (Repeater, Bridge, Concentrator, Switch),
       - Logical Segmentation (Router, Gateway);
Routing and Interconnection Mechanisms and Protocols: Source Routing, Spanning Tree, RIP, EGP;
TCP-IP Protocols: IP Addressing, TCP Transport Protocols (Role and Frame Structure), IP Network Protocols (Role and Frame Structure), Address Resolution Protocols (ARP, RARP), Control Protocol (ICMP)).

4. Perspective and evolution of industrial communication:
- Supervision and Control (see remote control of industrial processes).

MBE 237: Accounting and Labour Law

- Accounting: 1 credits (15 hours); L, T
  1. General information on cost accounting and business management
     - Objective;
     - Role;
     - Concept of charge.
  2. Charge analysis
     - Embedded expenses;
     - Direct, indirect costs;
     - Valuation of stocks.
  3. Full cost method
     - Purchase cost;
     - Cost of production;
     - cost price;
     - Calculation of results.

- Labour Law: 1 credit (15 hours); L, T
A- First part
  1. The concept of Law;
  2. The characters of the Law Rule;
  3. Sources of Law (Hierarchical norms);
  4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
  5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
  6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression).

B- Second part
  1. Sources of Labour Law
  2. The different employment contracts (classic contracts and precarious contracts)
  3. Execution of the employment contract (salary and salary claim, various professional sanctions)
  4. Dismissal and resignation;
5. Resolution of labor disputes

**MBE 241: Mathematics IV**

- **Mathematics IV**: 4 credits (60 hours); L, T, SPW
  1. One-dimensional descriptive statistics;
  2. Linear regression;
  3. Calculation of probabilities;
  4. Laws of probability;
  5. Sampling and
  6. Estimation method;
  7. Chi-square hypothesis test.

**MBE 242: Computer Science II**

- **Computer Science II**: 5 credits (75 hours); L, T, P, SPW
  1. Introduction
  2. Fundamental elements
    - Problem and algorithm;
    - Program and programming language;
    - From the problem to the computer solution;
    - The paradigms of programming;
  3. Concepts of programming in C++
    - Presentation and description of the programming language;
    - Structuring a program;
    - Descriptions of Data, Actions;
    - Programming style.

**MBE 243: Planning, Intervention and Elements of Biology**

- **Planning and Intervention**: 1 credit (15 hours); L, T, SPW
  1. National policy of Health Technology in Cameroon
    - Some indicative figures to illustrate the maintenance situation in Cameroon;
    - Endogenous problems;
    - Exogenous problems.
  2. Maintenance
    - Different definitions and standards;
    - Maintenance and reliability of medical equipment;
    - The objectives of the maintenance;
    - The need for maintenance;
    - Maintenance activities.
3. **Operational safety**
   - Field of competence;
   - Functional analysis;
   - Dependability allowance.

4. **Procedure for reforming**
   - Plan for the acquisition of maintenance equipment;
   - Reforming procedure;
   - Maintainability.

5. **Tools of Maintenance management**

   - **Elements of cellular and molecular biology:** 2 credits (30 hours); L, T, PW
     1. Introduction
     2. Basics of cellular biology
     3. Biochemistry and Bioenergetics
     4. Structure of DNA
     5. Notions of genes
     6. Cell membranes and vesicular transport
     7. Cellular communication
     8. Organization and renewal of tissues
     9. The immune system
     10. The Cancers

   - **MBE 244: Biomedical equipment Management**
     - **Biomedical equipment Management:** 4 credits (60 hours); L, T, PW
       1. Introduction and objectives
       2. The Inventory:
          - Definition;
          - Importance in the management of biomedical equipment.
       3. Different types of inventories
       4. Nomenclature in an inventory
          - Nature and quality of articles;
          - Nature and qualities of the information.
       5. Management of a park of biomedical equipment
       6. Computerized management system
       7. Conclusions

   - **MBE245: Fault diagnosis and Practical Work on Medical imaging**
     - **Fault diagnostic:** 1 credits (15 hours); L, P
       1. Reminders about maintenance in general
          - Types of maintenance (curative, preventive and predictive);
          - Levels of maintenance;
          - Organization of maintenance.
2. **Communication concept**
   - Diagram of the communication;
   - Barriers in communication (distortion and loss of information);
   - Why intervene?
   - Report and report.

3. **Troubleshooting Methodology**
   - Specification of the problem;
   - Careful examination of the real functioning;
   - User survey;
   - Accurate identification of defects;
   - Location and extent of the failure;
   - Formulation of the specification;
   - Decomposition of a block system;
   - Definition of blocks;
   - Look for bad blocks in a system;
   - Analytic and synthetic approach;
   - search differences and changes;
   - Formulation of possible causes;
   - Test the most likely cause;
   - Search for the defective block;
   - Repair, control and testing

- **TP Imaging technique: 2 credits (30 hours); P**

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**MBE 246: Professional internship**

- **Professional internship: 6 credits (90 hours); P, SPW**
  1. Arrival and integration in the companies
  2. Work in a company
  3. Keeping the trainee journal
  4. Choice of the working theme in collaboration with the professional supervisor and the academic supervisor
  5. Development of the research framework
  6. Resources to exploit
  7. Organization of work
  8. Writing the report
  9. Presentation of the report before a jury

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**MBE 247: Economy and business organization**

- **Economy and business organization: 3 credits (45 hours); L, T, SPW**
  1. **Concepts of General Economics**
     - Introduction;
     - Consumption and production;
- Income training;
- Money and Credit;
- Prices;
- The notion of growth and development.

2. **The Company**
   - Introduction;
   - Typology of companies;
   - Structure and organization of the company;
   - Business and Ethics;
   - How to undertake (Create, Decide, and Manage).

3. **The place of the company in the economic environment**
   - Concept of the business environment;
   - Inter and extra-company relations;
   - Commercial activity;
   - Concept of Strategy.

4. **Productive activity**
   - Production policies and processes;
   - Trade policies;
   - Logistics.

5. **The Concept of Management in the Company**
   - Activity and financial resources;
   - Planning and management of human resources;
   - Planning and management of material resources.

6. **Information and Communication in the Company**
   - Role of information and communication;
   - Collection and organization of information;
   - Strategic diagnosis;
   - Decision system.
Field : ELECTRICAL AND ELECTRONIC ENGINEERING

Specialty : CONTROLE, INSTRUMENTATION AND REGULATION
1. The objective of the training

The specialty “CONTROL, INSTRUMENTATION AND REGULATION” aims to train specialists able to design, install, program, control, activate, optimize and maintain electrical installations.

2. Research Skills
   → Generic skills :
   - Work independently and in team collaboration;
   - Analyze, synthesize professional documents (French, English);
   - Orally and writing communication (French, English);
   - Participate in (other) lead project management process;
   - Know and exploit professional and institutional networks of electricity sectors.

   → Specific skills
   - Design, supervision of the installation;
   - Programming and commissioning of all or part of industrial control and automatic regulation systems;
   - Maintenance, evolution and optimization of all or part of industrial control and automatic regulation system;
   - Research and validation of new technologies to optimize necessary measures for production;
   - Feedback analysis: experimental data or processes.

3. Career opportunities
   - Instrument Technician;
   - Instrumentation-regulation maintenance technician;
   - Installation technician in control systems;
   - Supervisor of works;
   - Technician of office of study and method;
   - Operating Technician, and supervisor;
   - Automation and regulation technician;
   - After-sales service technician;
   - Repair technician.
4. Organization of the Teachings

- **FIRST SEMESTER**

<table>
<thead>
<tr>
<th>Field: Electrical and Electronic Engineering</th>
<th>Specialty: Control, Instrumentation and Regulation (CIR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>Course titles</td>
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<tr>
<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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</tr>
<tr>
<td>CIR111</td>
<td>Mathematics I</td>
</tr>
<tr>
<td>CIR112</td>
<td>Physics and Chemistry I</td>
</tr>
<tr>
<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
<td></td>
</tr>
<tr>
<td>CIR113</td>
<td>Basics of Electricity and Electrical circuit</td>
</tr>
<tr>
<td>CIR114</td>
<td>Electrical Machines</td>
</tr>
<tr>
<td>CIR115</td>
<td>Electronics and automation</td>
</tr>
<tr>
<td>CIR116</td>
<td>Construction Design</td>
</tr>
<tr>
<td><strong>Transversal Courses 10% (1 UC) 3 credits 45 hours</strong></td>
<td></td>
</tr>
<tr>
<td>CIR117</td>
<td>Bilingual Training</td>
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- **SECOND SEMESTER**

<table>
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<tr>
<td><strong>Fundamental Courses 30% (2 UC) 9 credits 135 hours</strong></td>
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</tr>
<tr>
<td>CIR121</td>
<td>Mathematics II</td>
</tr>
<tr>
<td>CIR122</td>
<td>Physics and Computer Science</td>
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<tr>
<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<tr>
<td>CIR123</td>
<td>Measurement Technology and Microprocessor</td>
</tr>
<tr>
<td>CIR124</td>
<td>Electronics and signal processing</td>
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<tr>
<td>CIR125</td>
<td>Power Electronics and actuator control</td>
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<tr>
<td>CIR126</td>
<td>CAD in Electrical Engineering</td>
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<tr>
<td><strong>Transversal Courses 10% (1 UC) 3 credits 45 hours</strong></td>
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<tr>
<td>CIR127</td>
<td>Business creation, Civil and ethical Education</td>
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## THIRD SEMESTER

<table>
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<tr>
<td>CIR231</td>
<td>Mathematics III</td>
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<tr>
<td>CIR232</td>
<td>Physics and Chemistry II</td>
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</table>

### Fundamental Courses 30% (2 UC) 9 credits 135 hours

### Professional courses 60% (4 UC) 18 credits 270 hours

CIR233 Instrumentation and measuring circuit
CIR234 Measuring chain
CIR235 Regulation and Data communication
CIR236 Automation and Advanced Logic/Practicals works Electronics

### Transversal Courses 10% (1 UC) 3 credits 45 hours

<table>
<thead>
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<th>Course Code</th>
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<th>Number Of Credits</th>
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<tr>
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<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>CIR237</td>
<td>Accounting and labour law</td>
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**Total**

225 80 110 35 450 30

## FOURTH SEMESTER

<table>
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<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>CIR241</td>
<td>Mathematics IV</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>CIR242</td>
<td>Computer science II</td>
<td>40</td>
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</tr>
</tbody>
</table>

### Fundamental Courses 30% (2 UC) 9 credits 135 hours

### Professional courses 60% (4 UC) 18 credits 270 hours

CIR243 Practical Work: Instrumentation and measuring circuit
CIR244 Maintenance and industrial networks
CIR245 Practical Work: Control and Regulation
CIR246 Internship

### Transversal Courses 10% (1 UC) 3 credits 45 hours

<table>
<thead>
<tr>
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</tr>
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<tr>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
</tr>
<tr>
<td>CIR247</td>
<td>Economy and business organisation</td>
<td>25</td>
<td>15</td>
</tr>
</tbody>
</table>

**Total**

190 50 90 120 450 30
5. Course contents

❖ CIR 111 : Mathematics I

➤ Mathematics : 4 credits (60 hours); L, T, SPW

1. Functions of a real variable.
2. Circular, hyperbolic, and reciprocal functions.
5. Taylor Formula and limited developments.
7. Multiple integrals and their applications to the calculation of area and volume.

❖ CIR 112 : Physics and Chemistry

➤ Physics : 3 credits (45 hours); L, T, P, SPW

1. Kinematics
   - Introduction;
   - Referential system and position vector;
   - Speed and acceleration;
   - Movement in the field of gravity.
2. Action of forces on a material point
   - Principle of inertia and fundamental principle of the dynamic;
   - The superposition of Forces;
   - The forces of inertia;
   - Friction and friction forces.
3. Gravitation
   - The force of gravitation;
   - Law of gravitation;
   - Fields of forces.
4. Work, Power, Energy and Momentum
   - Work;
   - Power;
   - Energy;
   - Momentum.
5. Action of the forces on a solid body
   - Static;
   - Kinetics of solid bodies.
6. Fluid Mechanics
   - Fluid and gas at rest;
   - Incompressible liquid.
Chemistry: 2 credits (30 hours); L, T, P, SPW

1. Nuclear Reactions
   - Describe the structure of a nucleus (Mass number, atomic number).
   - Characterization of isotopes;
   - Distinguish the different reactivity (spontaneous and non-spontaneous reaction);
   - Establish the equation of a radioactive transformation;
   - Assess the fault of mass and the energy released by a nuclear reaction;
   - Half-life of the radioactive decay;
   - Activity of radioactive isotopes;
   - Radiation protection;
   - Experimental strategy to quantify the radiation received in function of time, distance and materials crossed.

2. Pure body and mixtures
   - Distinguish between the different types of mixtures (suspensions, emulsions, alloys, aqueous solutions, smoke and fog);
   - Solubility of a solute in a solvent. Homogenous and heterogeneous Solutions;
   - Density of a solution, Molar concentration, Mass concentration, the molarity, molar fractions and mass concentrations.
   - Distinguish between the molar concentration of the normality;
   - Establish and apply the relations between sizes and molar mass quantities;
   - Describe and explain the operation of a process of liquid-liquid extraction;
   - Establish a balance sheet of overall material and partial to each of the constituents of a liquid-liquid extraction;
   - Articulate and apply the law of perfect gases;
   - Define the total pressure and partial pressures for a gaseous mixture;
   - Difference between absolute and relative pressure;
   - Establish the expression and evaluate the density of a real and a perfect gas;
   - Describe and explain the process of extraction liquid-gas: absorption and desorption;
   - Establish a balance sheet of overall material and partial to each of the components of an extraction liquid-gas.

3. Chemical reactions
   - Electronic structure of an atom;
   - Bonding (ionic and covalent bonds);
   - Molecular model of Lewis;
   - Establish an equation of reaction;
   - Establish a molar balance sheet;
   - Standard enthalpy of reaction;
   - Exothermic and endothermic reactions;
Chemical equilibrium of reaction: Equilibrium constant;

4. **Speed of chemical reaction**
   - Set the speed of a reaction by report to a reagent or product;
   - Define the constant speed;
   - Set the order of a reaction by report to a reagent and exploit the equation giving its concentration as a function of time;
   - Define the Time of half-reaction;
   - Identify the factors kinetics: influence of temperature and concentration from follow-up data on the reaction;
   - Explain the role of a catalyst;
   - Operate the curve giving the evolution of a composition of a reagent or a product in the time to identify the order of reaction and evaluate the speed constant and the time to half-reaction.

5. **Reaction in aqueous solution; Acidic, basic and oxido-reduction**
   - Define the specific vocabulary: acid, base according Brönsted, oxidizing, reducer;
   - Oxidation, reduction, torque acido-basic, redox couple;
   - Acido-basic reaction; redox highlighting: exchanges of protons and then of electrons;
   - Establish a link between the powers dissociating, dispersant and solvating of water and its physical properties and molecular structure;
   - Explain the particular case of the water: couples in the water, autoprotolyse, Ke, ampholyte;
   - The reactions acido-basic;
   - Redox reactions.

6. **Organic chemistry**
   - Identify the gross formulas, developed planes, semi-developed topological and isomers of Simple hydrocarbons (alkanes, Cyclanes, alkenes, benzene) and their derivatives (alcohol, carboxylic acid, aldehydes and ketones) and know the appoint;
   - Establish a link between the structure of a molecule of hydrocarbon and its chemical properties;
   - Distinguish between the three types of reactions in organic chemistry: substitution reactions, addition and elimination;
   - Distinguish monomer and polymer;
   - To distinguish the types of reactions of polymerization;
   - Describe the properties of a few industrial polymers.

---

**CIR 113: Basics of Electricity and Electrical Circuits**

- Basics of Electricity and Electrical Circuits 5 credits (75 h); L, T, PW

  1. **Mathematical tools**
     - Elements of vector calculation (coordinate systems, scalar and product, vector product);
     - Scalar Field, Vector Field, and Field Vector Flow.
2. **Electrostatic field and potential**
   - Electrostatic field;
   - Electrostatic potential;
   - Work of an electrostatic force;
   - Distribution of electrical charges;
   - Electric dipole;
   - Electrostatic field flux - Gauss theorem.

3. **Magnetic induction - Ampère theorem**
   - Lorentz force and magnetic induction (Lorentz force, motion of a charged particle in an uniform electric field and in a uniform magnetic field);
   - Magnetic effects of the currents (Laplace and BIOTSAVART Law, Notion of current density);
   - Magnetic flux induction, Ampère theorem;
   - Magnetic induction created by a circular conductor at a distant point, Magnetic moment concept.

4. **Work of electromagnetic forces**
   - Movement of a circuit in a magnetic field;
   - Notion of inductance (self-inductance, mutual-inductance);
   - Applications.

5. **Electromagnetic induction**
   - Displacement of a conductor in a uniform magnetic induction (Electromagnetic field and induced emf, LENZ law, Notion of generator and motor);
   - FARADAY’S induction law (Self-induction, EMF of self-induction, Establishment and extinction of a current in a RL-circuit);
   - Magnetic energy;
   - Applications.

6. **Capacitances-capacitors**
   - Capacitance of an isolated capacitor (Definition, Capacitance of a conducting sphere);
   - Capacitor (Definition, Load carried by the armatures: case of a spherical capacitor to simplify);
   - Grouping of capacitors;
   - Charging and discharging a capacitor through a resistor.

7. **Single phase alternating current**
   - Reminders on complex numbers;
   - Sinusoidal voltages and currents;
   - Ohm's Law in A C;
   - Dipole in AC;
   - Power in AC systems single phase;
   - Power balance in a circuit - Boucherot's theorem.

8. **Three-phase sources**
   - Balanced sources: sinusoidal voltages and currents;
   - Balanced three-phase loads;
- Unbalanced loads;
- Three-phase AC power

**Electrical circuits: 2 credits (30 hours): L, T, SPW**

1. **Direct current electrical circuit:**
   - Electric dipole: definition, current and voltage as oriented quantities, linear dipole, nonlinear dipole, active and passive dipole, static characteristic, convention of the senses and energetic behavior, linear resistance and Ohm's law, nonlinear resistance;
   - Methods of analysis of DC linear circuits: Kirchhoff’s laws, Helmholtz's theorem, mesh currents method, Millman’s theorem;
   - Interaction between an active dipole and a variable passive dipole: voltage, current intensity, power, internal losses, efficiency, power adaptation;
   - Simplification of linear circuits: passive linear circuits (equivalence theorems, Kennely's law), active linear circuits (Thévenin's theorem, Norton's theorem).

2. **Periodic phenomena**
   - Periodic electrical quantities: period, frequency, continuous value, rms value, active power, oscillation, characteristic ratios of periodic quantities;
   - Sinusoidal electrical oscillations: characteristics (amplitude, pulsation, phase at the origin), average values, superposition, representations (Fresnel vector, complex symbol);
   - Non-sinusoidal electrical oscillations: Fourier series of a non-sinusoidal oscillation, Specific definitions of the non-sinusoidal electrical regime (rms value, active power, apparent power, power factor, reactive power, distortion power, harmonic rate, ripple, etc.), Response of a linear circuit to a non-sinusoidal excitation.

3. **Linear electric circuit in fixed frequency sinusoidal mode:**
   - Notion of linearity of electric dipoles in sinusoidal excitation;
   - Modeling passive linear elementary dipoles: Ohm's laws, electrical dipole behaviors in sinusoidal excitation;
   - Linear diodes in sinusoidal mode: instantaneous power, active power, apparent power, reactive power, power factor, complex power;
   - Linear circuits in sinusoidal regime: Kirchhoff laws, association of passive elementary dipoles, simplification of passive linear circuits (laws of division of voltage and current, Kerrely's law), resonance, simplification of active linear circuits (power of the source, Thévenin's theorem, Norton's theorem), power adaptation, compensation, analysis methods (Kirchhoff's laws, Helmholtz's theorem, mesh currents method, Millman's theorem);
   - Electrical quadrupole concept: parameters, input and output impedances, wave resistance and apparent power matching, image impedances.
4. **Linear electrical circuit and sinusoidal excitation with variable frequency:**
   - Expression of parameters as a function of frequency;
   - Response of a linear circuit to sinusoidal excitation when the frequency varies;
   - Parameter locations and their inversion, transfer function, amplification or gain;
   - Diagram of Bode and Nyquist;
   - Classic filters.

5. **Establishment and interruption of the electric current in a linear circuit:**
   - Switching of a linear circuit (RL, RC, RLC) subjected to a constant voltage;
   - Switching of a linear circuit (RL, RC, RLC) subjected to a sinusoidal voltage.

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CIR 114: Electrical machines I

- **Electrical machines I:** 5 credits (75 h); L, T, SPW

**A. DC machines**
1. Magnetic circuit
2. Constitution and operating principle
3. Modeling and characteristics (construction of Picou ...)
4. Energy balance
5. Reversibility of DC machines
6. Operating as Generators of different types of dc machine
7. Operating as Motors operation of different types of dc machine
8. Scope, selection and maintenance of DC machines

**B. Transformers**
1. **Single phase transformers**
   - Constitution and operating principle;
   - Design and diagrams;
   - Characteristics and tests;
   - Energy balance;
   - Operating conditions of machines connected in parallel.

2. **Three-phase transformers**
   - Constitution and operating principle;
   - Connection of windings, inflation of windings;
   - Phase displacement, characteristic and tests.

3. **Special transformers (for measuring)**
   - Self-transformer;
   - Voltage transformer;
   - Current transformer.

4. **Choice of Transformers and Maintenance**
CIR 115: Electronics and Automatism

- Automatism ant Practical Work : 3 credits (45 hours); L, T, P

A. Preliminary considerations and essential relating to industrial automation

1. **Introduction**
   - Definition and Concept;
   - Functions and objectives;
   - Requirement and complexity.

2. **The bases of the Boolean algebra**

3. **Method of analysis**
   - Method of chronograms;
   - Method of Karnaugh.

4. **Method of Synthesis**
   - Synthesis by wired technology;
   - Grafcet Method (Analysis Grafcet);
   - Synthesis and Technologies.

B. Essential considerations relating to Industrial Automation with programmable technology

1. **Definition and Concepts**

2. **Technology of industrial automation, criteria of choice**

3. **Industrial Automation API**
   - The programmable automation industrial;
   - Hardware and functional organization;
   - Interfacing and extension;
   - Choice of appropriate Automation.

4. **Study of an appropriate Automation (according to availability)**
   - Architecture and environment;
   - Programming language;
   - Implementation and choice.

5. **Practical work in laboratory**

- Electronics 1 : 2 credits (30 hours); L, T, SPW

1. **Basical notions of semi-conductors**

2. **The Diodes**
   - Current-Voltage characteristics of the an ideal diode;
   - Current-Voltage characteristics of a real diode;
   - Operating limits;
   - A few special diodes;
   - Notions of operating-point;
   - Applications of diodes.

3. **Bipolar Transistor**
   - Introduction;
- Structure and operation;
- Characteristics of an NPN;
- Operating Limits;
- Notions of operating-point;
- Dynamic model.

4. **Field Effect Transistor (FET)**
   - Introduction;
   - Current-Voltage characteristics;
   - Different Types of FET;
   - A few circuits of polarization;
   - Applications of FET.

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**CIR 116: Construction Design**

- **Construction Design: 3 credits (45 hours) L, T, SPW**

1. **Generalities**
   - Generalities on drawing;
   - Dimensional dimensioning of a drawing
   - Connections.

2. **Perspective**
   - Perspective projection of a drawing;
   - Axonometric perspectives.

3. **Projections**
   - Plan reading.

4. **Cuts and sections**
   - Different kinds of cuts;
   - Different kinds of sections;
   - Overall drawing;
   - Drawing for definition

5. **Mechanical connections**
   - Connectors (threaded and unthreaded);
   - Types of links;
   - Characteristics of a link.

6. **Adjustments**
   - Tolerance ratings;
   - Adjustments.

7. **The guides**
   - Translation guidance;
   - Rotational guidance;
   - Blocking concept;
   - Concept of lubrication.
CIR 117: Bilingual training

- **English**: 1.5 credits (22 hours 30mn); L, T, SPW
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication
  4. **Autonomous reading of "writings" of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
     - C.V;
     - Letter of motivation;
     - Letter/memo writing and minutes of a meeting

- **French**: 1.5 credits (22 hours 30mn); L, T, SPW
  1. **Vocabulaire**
     - Vocabulaire technique usuel
  2. **Grammaire**
     - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
     - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
     - Du nom et son article: masculin/féminin : singulier/pluriel ; dénombrable et non-dénombrable ;
     - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
     - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
     - Des fonctions grammaticales.
  3. **Expression et communication**
     - Compréhension et interaction au cours d’une discussion technique ;
     - Communication orale courante ;
     - Communication orale interactive ;
     - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
- Lecture rapide et compréhension de texte ;
- Synthèse de texte
- De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
- Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
- Expressions figées

**CIR 121: Mathematics II: 4 credits (60 hours); L, T, SPW**

- Mathematics II : 4 credits (60 hours); L, T, SPW
  1. Numerical Sequences.
  3. Fourier Series.
  4. Laplace transformation.
  5. Fourier transformation.
  6. Multi-variable functions- Scalar and vectors fields and their applications.

**CIR 122: Physics and Computer Science**

- Physics II: 2 credits (30 hours); L, T, P, SPW
  A. Oscillations and Waves:
    1. Kinematics of oscillating bodies
       - Generalities ;
       - The harmonic oscillator;
       - Superposition of oscillations.
    2. Dynamics of oscillating bodies
       - Free and damped oscillations
       - Forced and coupled oscillations.
    3. Waves
       - Generalities :
         - Harmonic waves; Groups of waves; Energy transport;
         - The superposition of waves;
         - Reflection, refraction and diffraction of waves;
         - Sound waves and ultrasound.

- Computer Science I : 3 credits (45 hours); L, T, P, SPW
  1. Generalities and vocabulary
     - Concept of information and informatics;
     - Resolution of problems by the informatics;
     - Typology and computer configuration;
     - Fields of application of informatics;
2. Information representation and processing
   - Systems of numbers;
   - Representation of Numbers and Characters (coding of information);
   - Booleanlogic;
   - Circuits of calculations & memory;
   - Presentation and differences between numerical & non-numerical data.

3. Structure and operation of a micro-computer
   - Architectures of a micro-computers;
   - Functional units (Central Unit, Units of entry and exit);
   - Architecture and performance of microprocessors;
   - Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
   - Presentation and roles of programs; their applications.

4. A Computer : An Interface “Machine (Hardware) - Man (Software)” as solutions to problems
   - The bios;
   - The systems of applications;
   - Application programs.

5. Operating systems and examples of operating system
   - WINDOWS (DOS);
   - Linux: an interesting alternative ;

6. A few examples of applications software
   - The ”Package Microsoft Office” (Word, PowerPoint, Excel);
   - The software of navigation and search engines on the Web.

CIR 123: Technics of Measurement and Electronics

- Measurement techniques: 2 credits (30 hours)
  1. Chains measurement
  2. Sensors
     - Principles of operation;
     - Choice of the principle and choice of the appropriate sensor;
     - Absolute, relative, differential sensors;
     - Range of measurement and sensitivity,
     - Dynamics sensor.
  3. Power electronics
     - Current and voltage supply;
     - Charge amplifier;
     - Sensitivity.
  4. Signal processing concept (in the data acquisition context)
     - Different types of signals;
     - Sampling;
     - The fall in the spectrum;
     - Digitization;
     - Fourier analysis;
5. **Measurement uncertainties**
   - Reminders of probabilities notions;
   - Mean, standard deviation, measurement duration;
   - Compositions of errors;
   - Distribution function;
   - Density of probability;
   - Normal and student distribution;
   - Robust estimators;
   - Histograms.

6. **Modeling of Measurements**
   - Correlation between two random variables;
   - Regression of first and second art;
   - Model of the least squares method;
   - Chi-square method;
   - Periodic effects;
   - Questionable measures;
   - Validation of the model;
   - Quality of the adjustment.

7. **Reference quantities and calibrations**
   - Reference quantities and transfer standard (for mechanical quantities);
   - Calibration and digital acquisition.

8. **Counting in digital acquisition**
   - Signals and encoders;
   - Tachymetric signals;
   - Proximity sensors;
   - Tachymetric sensors;
   - Real time;
   - Internal clock.

- **Electronics II and Practical Works: 3 credits (45 hours);**
  1. **Diodes**
     - Representation of the Current-voltage characteristics;
     - Half wave rectification;
     - Current-voltage characteristics of the Zener diode;
     - Stabilization of the voltage with the Zener diode.
  2. **Transistors**
     - Transistor characteristics and network;
     - Basic circuits of transistor amplifier;
     - Signal generating with RC-circuits;
     - Memory circuts (flip-flops);
     - RS, D, JK flip-flops.
  3. **Thyristors**
     - Influence of the trigger voltage on the current;
     - Use of thyristor as DC-voltage switch.
  4. **Operational amplifiers**
     - Basic circuits with operational amplifiers;
• Coding circuits;
• 8421-BCD converter / Exess 3;
• 8421-BCD decoder / 7 segments.

CIR 124: Electronics and Signal Processing

Electronics II: 3 credits (45 hours); L, T, SPW

1. Amplifier based on transistors
   • Characteristics of an amplifier;
   • Ideal amplifier;
   • Fundamentals Circuits.
2. Linear electronic with operational amplifier
   • The ideal Operational Amplifier;
   • Basics Circuits;
   • Active filters;
   • Sinusoidal oscillators.
3. Combinatory Logic
   • The binary system;
   • Transcoding;
   • Definition of the switching algebra;
   • Study of a few logical functions;
   • Modes of representation of logical functions;
   • Simplification of logical functions.

4. Introduction to the sequential logic
   • Memory circuits (flip-flops);
   • Analysis and synthesis of counters.

Signal Processing: 2 credits (30 hours); L, T

1. Definition and classification of signals
   • Continuous and discrete signals;
   • Periodic signals;
   • Simple transformations of signals and their visualization.
2. Sampling and quantification of signals
   • Quantification of signals;
   • Sampling of signals;
   • Criterion of Shannon-Nyquist;
   • Power of Signals.
3. Fourier transform
   • Definitions;
   • Periodic signals and time limited signals;
   • Fourier series and its properties;
   • Fourier transform and its properties;
4. Transfer function
   • Definitions and properties of the transforms of Laplace;
5. Introduction to filtering
   - Definition;
   - Impulse response;
   - Relationship input-output, discrete convolution;
   - Frequency response;
   - Transformed into Z.

6. Modeling of signals and numerical systems

CIR 125: Power electronics and actuator control

- Power electronics and actuator control: 4 credits (60 hours) L, T, SPW

A. Power electronics
   1. Introduction
      - General considerations;
      - Definition and objectives;
      - Different types of power conversion.
   2. AC / DC converter
      - Voltage rectifiers (with diodes, single and three-phase thyristors), internal operation;
      - Definition and measurement of input-output quantities;
      - Reversibility.
   3. DC / DC converters
      - Power transistors switching;
      - Study of basic choppers (direct link chopper, chopper, reversible chopper);
      - Isolated switching power supplies;
      - Symmetrical power supplies.
   4. DC / AC converters
      - Full wave voltage inverters (single-phase, three-phase);
      - UPS in PWM: Principles;
      - Uninterruptible power supply structures;
      - Technologies of storage batteries.
   5. AC / AC converters
      - Triacs technology;
      - Study of dimmers;
      - Study of cycloconverters.
   6. Thyristor and Triacs triggering device and circuit
      - DC and AC priming;
      - Pulse priming.
   7. Electronic controls of machines
      - Variable speed drive for DC machines;
      - Variable speed drive for AC machines.

B. Actuator control
CIR 126: CAD in Electrical Engineering

- CAD in Electrical Engineering: 4 credits (60 hours) L, T, SPW
  1. Choice of CAD-Software (s) and practical Information
  2. Presentation and description of the Software (s)
  3. Management of created Data
  4. Study and handling of different modules
  5. Applications to realization of a mini-projects

CIR 127: Business Creation and Civic and Moral Education

- Entrepreneurship: 1 credit (15 hours) ; L, T, SPW
  1. Entrepreneur concept
  2. Motivations for starting a business
  3. Ideas research and evaluation
  4. Financing research
  5. Choice of legal status

- Civic and moral education: 2 credits (30 hours); L, T
  The Concepts
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem ;
  - Ethics and management.
  - Civics
  - Deontology
  - Moral consciousness
  - The universal declaration of Human Rights
  - Good governance in public services
  - The importance of civics to the life of the nation
  - Functions of the state and its citizens
  - Deontlogy, Professional ethics and professionalism
  - Relationship between morality, law and ethics
  - Codes of ethics

CIR 231: Mathematics III

- Mathematics III : 4 credits (60 hours); L, T, SPW
  1. Linear systems;
2. Complex numbers;
3. Polynomials functions and rational fractions;
4. Vector spaces and Euclidean vector spaces;
5. Linear applications;

❖ CIR 232: Physics and chemistry III

❖ Physics III : 3 credits (45 hours); L, T, P, SPW

1. Thermodynamics
   - Temperature and thermal expansion;
   - Heat and fundamental principle of thermodynamics;
   - Change of state of the ideal gases;
   - Kinetic theory of heat;
   - Cyclical process: 2nd fundamental principle of thermodynamics;
   - Change of state;
   - Propagation of heat.

2. Electrodynamics and applications
   - Currents and fields;
   - Production of magnetic fields;
   - Induction phenomenon;
   - Alternating current;
   - Electromagnetic waves.

❖ Chemistry: Basics of Quality, Health, Safety and Environment 2 credits (30 h; L, T, P, SPW)

1. Management system of a company
   - Identify the management system of a company using the global standards ISO 9001 and 14001;
   - Use and master the vocabulary of management systems.

2. Fight against nonconformities and loop of continuous improvement.
   - Use and master the vocabulary of continuous improvement;
   - Identify the implementation of the continuous improvement loop, regardless of the domain or company involved: ascertain, isolate / contain, analyze causes, treat causes, measure effectiveness;
   - Identify nonconformities, their degree of severity and their consequences in any context;
   - Propose corrective and preventive actions, even improvement, within the limits of its field of intervention;
   - Respect the rules of traceability within the limits of its field of intervention.

   - Participate in a risk prevention analysis;
   - Participate in a dynamic risk impact analysis;
   - Implement a prevention plan or emergency plan in its area of intervention.
4. **Regulations and technical standards.**
   - Situate its action within the framework of the operational technical standards developed by the IEC TC 65: for example the IEC 61508, IEC 61326, IEC 62443, IEC 62424, IEC 62708 series, etc.
   - Recognize the pictograms, hazard classes and precautionary and prevention statements of the CLP Regulation;
   - Apply the rules of prevention, limitation or prohibition related to the REACH Regulation on substances and their uses, whether in the form of raw materials, in mixtures, or contained in "articles";
   - Apply ATEX regulations related to the control of risks related to explosive atmospheres;
   - Comply with the sorting instructions for end-of-life CIRA equipment, issued by the Waste Electrical and Electronic Equipment (WEEE) Directive.

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الف. **CIR 233: Instrumentation and measuring circuit I**

- **Instrumentation and measuring circuit I: 5 credits (75 hours): L, T, SPW**

A. **Theory of measurement and instrumentation**

1. **Elements of the theory of measurement and electronic instrumentation**
   - Definition and vocabulary of the measurement;
   - Physical quantities and sources of disturbances;
   - Measuring instrument concept.

2. **Modeling a measurement system**
   - Measuring system and instrumentation;
   - Role and principle of a measurement chain;
   - Universal model of a measurement chain.

3. **Implementation of a measurement chain**
   - Recommended method for conducting a measurement;
   - Characterization of measuring instruments and accessories.

4. **Exploitation of measurement results or data**
   - Measurement errors;
   - Principles and methods of calculating uncertainty;
   - Uncertainty calculation of a measurement chain;
   - Statistical analysis and quality of measuring instruments;
   - Quality concepts and standardization, standards, international organizations;
   - Unit system.

B. **Electronic Instrumentation**

1. **Sensors**
   - Definition and characteristics;
   - Principles of the sensors;
   - Sensor conditioners;
   - Sensor type: Temperature, Pressure, Displacement, Humidity.
2. **Measuring instruments**
   - Tension; Current; Impedance; Voltmeter; Ammeters; Multimeters;
   - Impedance meter; Qmeter.

3. **Instruments for generating and analyzing signals**
   - Oscillators; Generators; Impulses;
   - Generators of operation;
   - Spectrum analyzers.

4. **Instrument for visualization and recording of signals**
   - Oscilloscopes
   - Recorders x y.

5. **Data Acquisition Systems**
   - Instrumentation systems;
   - Analogue-Digital, Digital / Analog Conversions.

 mê CIR 234: Measurement chain

➢ Metrology and measurement chain
  1. **Introduction**
     - Definitions;
     - Description of an Industrial Process;
     - Elements of metrology.
  2. **The Chain of Measurement**
     - Generalities;
     - Characteristics of a measurement chain;
     - Classification of signals;
     - The various possible errors;
     - The types of standard errors.
  3. **Sensors**
     - Definition;
     - Presentation of different types of sensors.
  4. **Transmitters**
     - Definition and role;
     - Connection and parameterization;
     - Implementation;
     - Smart transmitter;
     - Choosing a transmitter and its environment.

 mê CIR 235: Regulation and Data Communication

➢ **Control and Regulation II: 3 credits (45 hours);**

  **Digital regulation**
  1. **Digital control-command systems**
     - General organization;
     - Interface with the site and with the operator;
     - Implementation: Configuration and Action;
     - Centralized multitasking system (real-time monitor concept, advanced language concept: programming).
2. Regulation in discrete time
   - Discrete system (discretization by sampling);
   - "Z" Transformed and difference equations;
   - Influence of the sampling period;
   - Discrete form of a PID controller;
   - Application to optimal control.

- Data Communication: 2 credits (30 hours):

1. Parallel I / O
   - Programmable circuits;
   - Study of a Parallel Interface Adapter (PIA);
   - Inputs / outputs by polling;
   - Masks.

2. Asynchronous serial interfaces

3. Conversion N / A and N / A
   - D / A conversion;
   - A / D conversion;
   - Control of an ADC / DAC card.

4. Parallel Interface Timer (PIT)

5. Presentation and application of a microcontroller

6. Data Communications and Local Networks
   - The need for protocols;
   - The TCP / IP model;
   - The ISO model;
   - Topology of Local Networks.

△ CIR 236: Practical Work Automation and Logic and Advanced Electronics

- Advanced Electronics : 2 credits (30 hours):L, T, SPW

A. analog electronics

1. Study of the differential pair
   - Operating conditions at equilibrium and out of equilibrium;
   - Differential common mode gain, TRMC.

2. Linear and non-linear electronics with OP Amplifier
   - Basic assemblies: inverter, integrator, negative resistance simulation;
   - Comparators: adjustable phase, zero threshold, hysteresis (schmitt trigger);
   - Multivibrators.

3. Oscillators (relaxation, direct component, integrated circuit)
   - The switching transistor and its implications;
   - Generation of triangular and square signals with timers.

4. Study of particular electronic functions
   - Regulated power supplies;
     - Recovery and filtering by capacitor;
     - Principles of regulations (series and parallel);
     - Zener diode and transistor regulation, use of a ballast;
- Protection of power supplies;
- Principle of switching power supplies;
  - A / D and D / A conversions:
    - Study of some specific circuits, especially in flash conversion.
  - Nonlinear amplification:
    - The push-pull class B and C;
    - Principle of the class D amplifier.
    - The phase locked loop (PLL):
      - The circuits of the VCO, the phase comparator;
      - Qualitative and quantitative study of the PLL loop: equation and gripping conditions.

➢ Practical Work: Automation and Logic: 2 credits (30 hours);

❖ CIR 237: Accounting and Labour Law

➢ Accounting: 2 credits (30 hours); L, T
  1. General information on cost accounting and business management
     - Objective;
     - Role;
     - Concept of charge.
  2. Charge analysis
     - Embedded expenses;
     - Direct, indirect costs;
     - Valuation of stocks.
  3. Full cost method
     - Purchase cost;
     - Cost of production;
     - Cost price;
     - Calculation of results.

➢ Labour Law: 1 credit (15 hours); L, T

A. First part
  1. The concept of Law;
  2. The characters of the Law Rule;
  3. Sources of Law (Hierarchical norms);
  4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
  5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
  6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression);

B. Second part
  1. Sources of Labour Law
  2. The different employment contracts (classic contracts and precarious contracts)
3. Execution of the employment contract (salary and salary claim, various professional sanctions)
4. Dismissal and resignation;
5. Resolution of labor disputes

❖ **CIR 241: Mathematics IV**

- Mathematics IV: 4 credits (60 hours); L, T, SPW
  1. One-dimensional descriptive statistics;
  2. Linear regression;
  3. Calculation of probabilities;
  4. Laws of probability;
  5. Sampling and
  6. Estimation method;
  7. Chi-square hypothesis test.

❖ **CIR 242: Computer Science II**

- Computer Science II: 5 credits (75 hours); L, T, P, SPW
  1. Introduction
  2. Fundamental elements
     - Problem and algorithm;
     - Program and programming language;
     - From the problem to the computer solution;
     - The paradigms of programming;
  3. Concepts of programming in C++
     - Presentation and description of the programming language;
     - Structuring a program;
     - Descriptions of Data, Actions;
     - Programming style.

❖ **CIR 243: Practical Work**

- Practical Work of instrumentation and measurement circuit; 4 credits (60 hours), P

❖ **CIR 244: Maintenance and Industrial Network: 4 credits (60 hours), P**

- Maintenance: 2 credits (30 hours)
  1. Industrial Maintenance Approach
     - Definition;
     - The maintenance service.
  2. Maintenance strategies
     - Concept of failure;
     - Concepts of maintenance,
     - Maintenance methods,
     - Maintenance levels.
- The maintenance service.

3. **Organization of a maintenance service**
   - The company's assets;
   - The functions of the maintenance department;
   - Structuring of the maintenance service.
   - The maintenance service.

4. **Maintenance documentation**
   - General documentation;
   - Strategic documentation.

- **Industrial Network**: 2 credits (30 hours)

1. **Local Business Network**:
   - Ethernet Network: Functionality, Architecture, Wiring, Operation, OSI Model Analogy;
   - Industrial applications.

2. **Field networks**:
   - Industrial context;
   - Distribution - Decentralization of industrial applications;
   - Communication models: Client - Server; Producer - Consumer;
   - Automation networks: Specificities, Protocol study, Analogy to the OSI model, Standardization, Application cases (PROFIBUS, INTERBUS-S, MODBUS, DEVICE NET, MODLINK, ...);
   - Networks in Building Automation: Specificities, Study of the protocols, Analogy to the OSI model, Normalization, Cases of applications (BATIBUS, EIB, EHS, LONWORKS, ...);
   - International standardization.

3. **Interconnection of networks**:
   - Interconnection elements:
     - Physical Segmentation (Repeater, Bridge, Concentrator, Switch),
     - Logical Segmentation (Router, Gateway);
     - Routing and Interconnection Mechanisms and Protocols: Source Routing, Spanning Tree, RIP, EGP;
   - TCP-IP Protocols: IP Addressing, TCP Transport Protocols (Role and Frame Structure), IP Network Protocols (Role and Frame Structure), Address Resolution Protocols (ARP, RARP), Control Protocol (ICMP);

4. **Perspective and evolution of industrial communication**:
   - Supervision and Control (see order) remotely.

- **CIR245: Pratical work**

  - **Pratical work**: Control and Regulation: 4 credits (60 hours); P,S PW
    1. Digital regulation
2. Digital control-command systems
3. Regulation in discrete time

❖ CIR 246: Professional internship

➢ Professional internship: 6 credits (90 hours); P, SPW
1. Arrival and integration in the companies
2. Work in a company
3. Keeping the trainee journal
4. Choice of the working theme in collaboration with the professional supervisor and the academic supervisor
5. Development of the research framework
6. Resources to exploit
7. Organization of work
8. Writing the report
9. Presentation of the report before a jury

❖ CIR 247: Economy and business organization

➢ Economy and business organization: 3 credits (45 hours); L, T, SPW
1. Concepts of General Economics
   • Introduction;
   • Consumption and production;
   • Income training;
   • Money and Credit;
   • Prices;
   • The notion of growth and development.
2. The Company
   • Introduction;
   • Typology of companies;
   • Structure and organization of the company;
   • Business and Ethics;
   • How to undertake (Create, Decide, and Manage).
3. The place of the company in the economic environment
   • Concept of the business environment;
   • Inter and extra-company relations;
   • Commercial activity;
   • Concept of Strategy.
4. Productive activity
   • Production policies and processes;
   • Trade policies;
   • Logistics.
5. The Concept of Management in the Company
   • Activity and financial resources;
   • Planning and management of human resources;
   • Planning and management of material resources.
6. Information and Communication in the Company
   - Role of information and communication;
   - Collection and organization of information;
   - Strategic diagnosis;
   - Decision system.

The Minister of Higher Education

Pr Jacques FAME NDONGO
Field: THERMAL AND ENERGY ENGINEERING

Specialty:
AIR CONDITIONING AND REFRIGERATION
1. OBJECTIVE

The training of senior technicians in cold and air conditioning led to the control of multiple applications of the cold, since the conservation of food products up to the process of transformation and development of products: metallurgical industries, textiles, plastics, of the health, comfort in the major sets. The senior technician is centered on the cold chain and the treatment of the air (cold commercial, industrial and the air conditioning). It participates in the implementation of technical solutions taking into account the environment and the importance of energy savings.

2. RESEARCH SKILLS

→ Generic skills
  - Work in autonomy, collaborate as a team;
  - Analyze, synthesize, professional document (French, English);
  - Communicate to oral, written, in business or outside (French, English);
  - Participate in /conduct an approach to the management of the project;
  - Know and exploit the professional networks and institutional capacities of thermal sectors.

→ Specific skills
  - Perform the installation, commissioning and maintenance of refrigerated installation (Cold commercial, industrial cold, ...) or equipment of air conditioning and air conditioning according to the security rules and regulations;
  - Master the technologies related to climatic facilities, cold storage and electric;
  - Know the materials and equipment used;
  - Read and interpret the plans, the electrical schematics and the instruction sheets;
  - Meet the standards of quality, safety and the environment; and
  - To be able to reason with method and to detect an abnormal situation;
  - Design of facilities of cold or air conditioning; establish quote;
  - Identify the phases of intervention;
  - Install the equipment and materials in the respect of the technical dossier;
  - Put into service the facilities and train the users;
- Maintain facilities in good operating condition;
- Check the conformity of the installed equipment;
- Perform operations of Troubleshooting (including on installations of heaters).

3. EMPLOYMENT OPPORTUNITIES

- Agent of coaching in cold and air conditioning;
- Maintenance Technician in operating climate;
- Refrigeration Mechanic maritime;
- Convenience store in installation of cold and air conditioning;
- Assembler-convenience store in cold facilities and air conditioning;
- Technician Agent in cold and air conditioning;
- Driver of refrigeration facilities;
- Technician After-Sales Service (SAV) in air conditioning;
- Mechanic maintenance of climate systems and stores;
- Assembler-convenience store refrigeration mechanic;
- Technician to intervention and maintenance in cold and air conditioning;
- Agent of supervision of maintenance in cold and air conditioning;
- Maintenance Team Leader in cold and air conditioning;
- Technician of system maintenance of air filtration system.
4. Organization of the Teachings

**FIRST YEAR: FIRST SEMESTER**

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<th>Field: Thermal and Energy Engineering</th>
<th>Specialty: Air conditioning and Refrigeration</th>
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<tr>
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<td>Mathematics I</td>
</tr>
<tr>
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<td>Physics and Chemistry I</td>
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**Fundamental courses 30% (2 UC) 9 credits 135 hours**

**Professional courses 60% (4 UC) 18 credits 270 hours**

| ACR113 | Electronics and Electrical Engineering | 35 | 20 | 0 | 5  | 60   | 4 |
| ACR114 | Thermodynamics                        | 15 | 10 | 30| 5  | 60   | 4 |
| ACR115 | Thermal transfers                     | 40 | 15 | 0 | 5  | 60   | 4 |
| ACR116 | Fluid Mechanics and technique to measure | 55 | 30 | 0 | 5  | 90   | 6 |

**Transversal courses 10% (1 UC) 3 credits 45 hours**

| ACR117 | Written Expression and legal environment | 27 | 15 | 0 | 3  | 45   | 3 |

**Total**

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**FIRST YEAR: SECOND SEMESTER**

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<tr>
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<td>Mathematics II</td>
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<tr>
<td>ACR122</td>
<td>Physics and Computer</td>
</tr>
</tbody>
</table>

**Fundamental courses 30% (2 UC) 9 credits 135 hours**

**Professional courses 60% (4 UC) 18 credits 270 hours**

| ACR123 | Air conditioning                      | 35 | 20 | 0 | 5  | 60   | 4 |
| ACR124 | Regulation and management of energy   | 15 | 15 | 25| 5  | 60   | 4 |
| ACR125 | Automatic                             | 35 | 20 | 0 | 5  | 60   | 4 |
| ACR126 | Hydraulic and electrical diagrams applied to cold | 50 | 25 | 10| 5  | 90   | 6 |

**Transversal courses 10% (1 UC) 3 credits 45 hours**

| ACR127 | Creation of business and Civic education and Ethics | 25 | 17 | 0 | 3  | 45   | 3 |

**Total**

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### SECOND YEAR: THIRD SEMESTER

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<tr>
<td>ACR 231</td>
<td>Mathematics III</td>
<td>30</td>
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<tr>
<td>ACR 232</td>
<td>Physics and Chemistry II</td>
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<td></td>
<td><strong>Fundamental courses 30% (2 UC) 9 credits 135 hours</strong></td>
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<td>Cad and cam</td>
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<td>Practical work</td>
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<tr>
<td>ACR 235</td>
<td>Refrigerated warehouse and installation</td>
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<td>15</td>
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<td>ACR 236</td>
<td>Production of the cold</td>
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<td>Methodology of the drafting of the RDS</td>
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### SECOND YEAR: FOURTH SEMESTER

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<td>ACR 242</td>
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<td>Materials</td>
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<td>ACR 244</td>
<td>Electricity and technology of refrigerated facilities</td>
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<td>ACR 245</td>
<td>Refrigeration conservation</td>
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5. Course content

ACR111: Mathematics I

- Mathematics I: 4 credits (60 hours); L, T, PW
  1. **Real Numbers**
     - Ordered set, advancing, reduces, terminals upper and lower, maximum, minimum;
     - Concept of intervals;
     - Absolute value;
     - Integer part;
     - Rational fractions;
     - Equations and inequalities.
  2. **Complex numbers**
     - Algebraic Representation and module;
     - Trigonometric representation and argument;
     - Exponential representation and formula of Moivre;
     - Nth root of a complex;
     - Resolution of the equation of the 2nd degree in C;
     - Linearity, complex plan.
  3. **Digital suites**
     - Definition;
     - Of converging suites (limits, increasing suites and increased, decreasing and demeaned); Suite and criterion of Cauchy;
     - Arithmetic Suites and geometric;
     - Theorem of Bolzano-Weierstrass.
  4. **Numerical Functions of a real variable**
     - Reminders on the study of the relations in the ensembles: (definition of an application, applications injectives and subjective, concept of correspondence);
     - Domain of definition, limits and continuity;
     - Derived from the functions;
     - Table variations and graph functions;
     - The theorems of Rolle and formula of finished increases;
     - Rule of the Hospital, Taylor's formula and Developments Limited.
  5. **Usual functions**
     - Logarithm functions and exponential;
     - Trigonometric and hyperbolic functions.
  6. **Full calculations**
     - Decomposition of rational fractions in simple elements on R;
     - Integration of rational functions and stair;
     - Calculation of the integrals and the concepts of primitive;
     - Integrable function within the meaning of Riemann;
     - Ultimate unfit; ultimate dependent on a parameter;
     - Derivation under the sign of the integral;
     - Generalized integrals;
• Introduction on applications to the calculation of length, area and volume.

7. **Digital series and series of Fourrier**
   • Digital series: Series to positive terms, absolute convergence, General theorems;
   • Suites and series of functions of one real variable: convergence simple, uniform convergence, normal convergence, General theorems;
   • the entire series: Radius and interval of convergence, General theorems;
   • Plot of curves in polar coordinates;
   • Fourier series and exponential series.

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**ACR121: Mathematics II**

- **Mathematics II: 4 credits (60 hours); L, T, PW**

1. **Algebraic Structures**
   • Sets, applications, relationships;
   • The items of the theory of numbers;
   • introduction to the theory of groups;
   • Rings and body.

2. **Linear algebra**
   • Vector spaces;
   • Linear applications;
   • Matrix calculation (matrices, determinants, and applications, diagonalization, triangularisation, etc.);
   • System of linear equations;

3. **Boole's algebra**
   • Introduction to Boolean logic;
   • Numbering systems;
   • Logical function and theorem of decomposition;
   • Simplification of Boolean functions;
   • Elements of Formal Logic;
   • Application to logical circuits.

4. **Real function to several variables**
   • Field of scalars, vector field;
   • Partial derivatives;
   • Multiple integrals (double and triple rooms);
   • Gradient of a scalar field, theorem of Gauss;
   • Divergence and rotation of a vector field, theorem of Stokes;
   • Calculation of curves and surfaces in the full space curved and surface);
   • Laplacian of a field of scalars and of a vector field.

5. **Function Theory**
   • Definitions and Introductory Study.

6. **Differential Equations**
   • Differential Equations 1 order;
• Differential Equations of linear 2nd order with constant coefficients.

7. **Probability and Statistics**
   • Calculation of probabilities;
   • The laws of probability;
   • Statistics and methods of estimation.

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**ACR112: Physics and Chemistry**

➢ **Physics I: 3 credits (45 hours); L, T, P, PW**

**Mechanical**

1. **Kinematics**
   • Introduction;
   • Repository system and vector of position;
   • Speed and acceleration;
   • Movement in the field of gravity.

2. **Action of the forces on a hardware point:**
   • Principle of inertia and fundamental principle of the dynamic;
   • The superposition of the Forces;
   • The forces of inertia;
   • Friction and friction forces.

3. **The gravitation:**
   • The force of gravity;
   • Law of gravitation;
   • Fields of forces.

4. **Work, power, energy and amount of movement:**
   • Work;
   • Power;
   • Energie;
   • Amount of movement.

5. **Action of the forces on a solid body:**
   • Static;
   • Kinetics of solid bodies.

6. **Fluid Mechanics:**
   • Fluid and gas in the rest;
   • Disposal of liquid incompressible.

➢ **Chemistry: 2 credits (30 hours); L, T, P, PW**

1. Structure of Matter
2. Chemical analysis
3. Chemical Notation Introduction
4. Chemical reaction and chemical equation
5. The refrigerants
6. The refrigerated oils
7. Chemistry and the environment: impacts of fluids and substances used in cold and air conditioning on the environment
8. Food Microbiology
9. Methods of conservation
10. Optimal condition for the refrigerated storage
11. Conservation of animal and plant products

**ACR122: Physics and computer science**

- **Physics II: 2 credits (30 hours); L, P**

  **The Oscillations and Waves**

  1. **Kinematics of the oscillating body**
     - General information;
     - The harmonic oscillator;
     - Superposition of oscillations.

  2. **Dynamics of oscillating body**
     - The harmonic oscillator free;
     - Amortization;
     - Forced oscillations and coupled oscillations.

  3. **Air Waves**
     General information;
     Harmonic waves;
     Transport of energy;
     Groups of waves;
     - The superposition of the waves;
     - The reflection, refraction and diffraction of the waves;
     - sound waves and ultrasound.

- **Computer Science I: 3 credits (45 hours); L, P, PW**

  1. **General information and vocabulary**
     - Concept of information and informatics;
     - Resolution of the problems by the informatics;
     - Typology and computer configuration;
     - Fields of application of informatics;

  2. **Representation and processing of the information**
     - Systems of numbers;
     - Representation of Numbers and Characters (coding of information);
     - Boolean logic;
     - Circuits of the calculations & memory;
     - Presentation and differences between digital data & non-numeric data.

  3. **Structure and operation of a micro-computer**
     - Architectures of micro-computers;
     - Functional units (Central Unit, Units of entry and exit);
     - Architecture and performance of microprocessors;
     - Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
     - Presentation and roles of the programs, their applications.
ACR 113: Electronics and Electrical Engineering

Electronic : 2 credits (30 hours): L, T, PW

A. Analog electronics

1. A few helpful reminders
   - Linear components and Ohm’s law;
   - source of current and source of voltage;
   - theorem of thévenin.

2. The Diodes
   - Current characteristic - Voltage of the ideal diode;
   - Current characteristic - Voltage of a real diode;
   - Operating limits;
   - A few special diodes;
   - Notions of Point of operation;
   - Applications of diodes.

3. Bipolar Transistor
   - Introduction;
   - Structure and operation;
   - Characteristics of a NPN;
   - Operating Limits;
   - notion of Point of operation;
   - dynamic model.

4. Field Effect Transistor
   Introduction;
   Current characteristics - Voltage;
   Different Types of FET;
   a few circuits of polarization;
   applications of FET.

5. The amplifiers to transistors
   - Characteristics of an amplifier;
   - the perfect amplifier;
   - Fundamental mounts.

6. The linear electronic with operational amplifier AO
   - The PDO ideal and actual;
   - Mounts of basis;
   - Active filters;
   - Sinusoidal oscillators.

7. Introduction to the electronic non-linear
   - Dial adjustable threshold and zero threshold;
   - Dial hysteresis;
   - Multivibrator astable.

B. Digital electronics

1. The Combinatorial logic
   - the binary system;
   - Transcoding;
• Definition of the algebra of switching;
• Study of a few logical functions;
• Modes of representation of logical functions;
• simplification of logical functions.

2. **Introduction to the sequential logic**
• The elements Memoirs: flip-flops
• Analysis and Synthesis of counters

C. Practical work

1. **Theme 1: The Diodes**
• Representation of the characteristic Current - Voltage;
• Simple Recovery alternately;
• Current characteristics-voltage of the Zener diode;
• stabilization of the tension with the Zener diode.

2. **Theme 2: The transistors**
• Networks of characteristics of the transistors;
• Mounts of basis of amplifiers for transistors;
• signal generators with circuits of R, C.
• the memory elements (scales);
• RS-Type Latches, D, JK.

3. **Theme 3: The thyristors**
• Influence of the voltage of trigger on the current;
• Use of the thyristor as switch in continuous voltage.

4. **Theme 4: Operational Amplifiers**
• mounts of basis for operational amplifiers.
• The circuits of coding;
• 8421 converter-BCD / Excess 3;
• 8421 decoder-BCD / 7 segments.

5. **Theme 5: The circuits of multiplexing**
• The oscillators to relaxation;
• Dial gauge to threshold value;
• Dial gauge to hysteresis;
• Generator of triangular pulses;
• Astable multivibrator

6. **Theme 6: The circuits of counting**
• meter asynchronous and synchronous ;
• programmable counters.

**Electrotechnics : 2 credits (30 hours); L, T, PW**

1. General information on electrical engineering
2. Basic component of Electrical Engineering
3. Induction motor and 3 Phase 1 Phase
4. Transformer
5. Alternator
6. Starting of engines
**ACR123: Air Conditioning**

- Air conditioning - Ventilation: 4 credits (60 hours); L, T, PW
  1. The psychométrie
  2. The treatment of the air
  3. The indoor environment; concept of thermal comfort
  4. Study of air conditioning systems, ventilation and air conditioning
  5. Heat balance of air conditioning
  6. Technology of equipment and components of the systems of air conditioners
  7. Study and calculation of networks of air (ducts)
  8. Notions of acoustics and acoustic insulation in air conditioning

**ACR114: Thermodynamics**

- Thermodynamic : 4 credits (60 hours); L, T, PW
  1. Reminders and additions mathematics and general information on the thermodynamics
  2. Fundamental relations of thermodynamics
  3. The first principle of thermodynamics
  4. Second principle of thermodynamics
  5. Study of perfect gases
  6. Calorimetry
  7. Thermometry

**ACR124: Regulation**

- Regulation and management of energy: 4 credits (60 hours); L, T, P, PW
  1. Introduction to the regulation and the automatic
     - Purpose;
     - Definitions;
     - Basic Principles.
  2. Mathematical description and linear dynamic systems types (1 and 2\textsuperscript{nd} order)
     - Modeling and equation;
     - Laplace transformation;
     - Transfer function;
     - Temporal analysis;
     - Performance of Systems (response time, stability, precision, overflow, etc.).
  3. Regulation of industrial systems (Basics)
     - Operational objectives;
     - Modes of regulation;
     - Technology of the regulators;
     - Regulation procedure and application to a few examples in the industry and in cold.
4. **Regulation of refrigerated facilities**
   - Objectives and specificities of the Regulation of refrigeration circuits;
   - Study of a few techniques of regulation: temperature, pressure, the refrigerant level, oil, vacuum, de-icing;
   - Study of flow regulators of power in fluid (different regulators).

5. **Regulation of systems in air conditioning**
   - Study of a few regulating systems used in air conditioning (central processing of air, systems to direct relaxation, group of production of ice water, fan-coil units, pumps in icy water, systems VRV, etc.).

6. **Introduction to the technical management of the building and to the rational use of energy in air conditioning in the building**

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**ACR115: Thermal transfers**

- Thermal transfers: 4 credits (60 hours); L, T, PW

**A. First part**

1. Reminders and additions mathematics and general information on the thermal transfer
2. **Conduction**
   - Law of Fourier and its applications.
3. **Conduction**
   - Equation of conduction and resolution for a few simple configurations in permanent regime (wall simple plan and composite, hollow cylinder, problems with generation of heat).
4. **Convection**
   - Concept of boundary layer,
   - Concept of dimensional analysis;
   - Dimensionless numbers,
   - Empirical correlation in convection (free convection, forced);
5. **Thermal radiation**
   - Description of the phenomenon;
   - Physical quantities used;
   - Laws of the thermal radiation;
   - Calculations of radiative exchanges for simple configurations.

**B. Second part**

1. **Heat Exchangers**
   - Technological Study;
   - Physical principles and equations of the heat exchangers;
   - calculations and sizing.
2. **Thermal insulation**
   - Case of walls in Building;
   - Cold rooms;
   - Cases of pipes;
   - Calculation and choice of optimal thicknesses of insulation.
แลก ACR 125: Automatic

- **Autatism cold**: 4 credits (60 hours); L, T, PW
  1. Reminders on the regulation in cold: goal, the regulatory bodies, basic principles, thermostatic regulation and Presso static, dégivrages, etc.
  2. Notions of logic and combinatorial analysis
  3. Concept of logical and sequential analysis (modeling by a flow chart and Grafcet)
  4. Architecture of the programmable controllers and digital regulators
  5. Programming and setting parameters of the automata and digital regulators
  6. Electrical diagrams with automata and digital regulators

แลก ACR116: Fluid Mechanics and measure technics

- **Fluid mechanics**: 3 credits (45 hours); L, T, PW
  1. Introduction to the mechanical
  2. Kinematics of the material point
  3. Dynamics of the material point
  4. General information on the fluids and a continuous medium.
  5. Static fluids
  6. Kinematics of fluids
  7. Dynamics of perfect fluids
    - The equations of conservation (material, quantity, of movement, energy) and applications.
  8. Dynamics of real fluids
    - Viscosity;
    - Dimensional analysis;
    - types of flows;
    - losses of loads.
  9. The turbo machinery (pumps, fans, turbines)
    - Description;
    - Classification;
    - The study of the flow of particles of fluids in the wheel of turbomachinery (Triangle of speeds);
    - Performance of turbomachinery (Work exchanged, power, yields, available pressure, gauge heights etc.);
    - laws of similarities.

- **Technique of measurement**: 3 credits (45 hours); L, T, PW
  1. The sensors
    - Principles of operation;
    - Choice of the principle / choice of sensor;
    - Absolute sensors, relating, differentials;
    - Measuring range and sensitivity, dynamics of the sensor.
  2. The electronic packaging
    - Current power supply / Voltage;
3. **Concept of signal processing (in the context of the acquisition of data)**
   - Different types of signals;
   - Sampling;
   - The downturn of spectrum;
   - Scan;
   - Fourier analysis;
   - estimate of the DSP;
   - filtering.

4. **The uncertainties of Measures**
   - Reminders of probabilities;
   - Average, gap-type, duration of measurement;
   - The compositions of the errors;
   - Distribution function, density of probability;
   - Normal distribution, Student;
   - robust estimators;
   - histograms.

5. **Modeling of the measures**
   - Correlation between two random variables;
   - Regression of first and second species;
   - The Models: method of least squares, method of the chi-square;
   - Periodic effects;
   - Questionable measures;
   - Validation of the model;
   - Quality of the adjustment.

6. **Reference variables and calibrations**
   - Reference variables and transfer standard (for the magnitudes of the mechanical);
   - Calibration and digital acquisition.

7. **The Counting in digital acquisition:**
   - Signals and encoders, tachymétriques signals;
   - Proximity sensors;
   - tachymétriques sensors;
   - real time, internal clock.

8. **Measures and units.**
9. **Errors and Uncertainties.**
10. **Measurement of refrigerated quantities**
    - Pressure;
    - Temperature;
    - Refrigerated powers;
    - Air speed;
    - Flow of air;
    - Water flow;
    - Quantity of heat.
11. Measuring electrical quantities
- Voltage;
- Intensity;
- Resistance;
- Impedance;
- Capacity;
- Inductance;
- Electrical power.

❖ ACR 126: Hydraulic and Electrical Wiring Diagrams Applied to cold

➢ Hydraulic unit: 3 credits (45 hours); L, T, PW
1. Technology of turbomachinery (pumps, fans, turbines)
   - Description;
   - Operation;
   - Field of use.
2. Characteristic study of pumps
   - Characteristic curve pressure/flow rate;
   - Association of pumps (serial, parallel, mixed);
   - Cavitation of pumps (study of the NPSH);
   - Pump association/network; the operating point.
3. Technology of hydraulic networks
   - Pipes;
   - Organs annexs (bleed valves of air, buffer balloon, Expansion bottle, filters, valves, non-return valves, etc.).
4. Calculation of hydraulic networks
   - Calculation of the losses of load;
   - Sizing of pipes;
   - Selection of pumps;
   - selection of bodies annexs.

➢ Electrical diagrams applied to the cold: 3 credits (45 hours); L, T, P, PW

A. First part
1. General information on the diagram
   - Standards;
   - Definitions;
   - Types of diagram;
   - Symbols ;
   - Classification, etc.
2. Technology of electrical conductors
3. Study of the electrical equipment of command and power
   - Disconnector;
   - Circuit Breaker;
   - Switch;
   - Thermal relay;
   - Fuses ;
• Switches, etc.

4. **Electrical diagrams in domestic installations**
   • Lighting (single/double ignition, comes and goes, contactor/timer);
   • taken;
   • Signage.

5. **Electrical diagrams of facilities at driving force**
   • Direct start, 2 Direction of travel;
   • Star start/triangle;
   • Starting by auto transformer;
   • Starting by elimination of resistances;
   • Start of motorcycles hermetic compressors (per relay of intensity, Relay Voltage, PTC resistor);
   • Start of single phase motors by capacitor.

**B. Second part**

1. **Electrical diagram of facilities with thermostatic regulation, préssostatique and mixed**

2. **Electrical diagram of facilities with regulation by vacuum**

3. **Electrical diagram of facilities with de-icing of the evaporators**
   • Forced ventilation;
   • Electrical resistors;
   • hot gases;
   • Inversion of cycle.

4. **Electrical diagram of the facilities with the use of the different possibilities of safety line**

5. **Integration of different types of starts in an electrical diagram refrigerated equipment**
   • Direct;
   • Star/triangle;
   • hand-winding;
   • Relay "KRIWAN".

6. **Electrical diagram of compact equipment:**
   • Refrigerators;
   • Freezers;
   • Air Conditioner (Windows, split system);
   • Machines to ice, etc.

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**ACR117: Written Expression and legal environment**

- **Written Expression:** 1 credit (15 hours); L, T, PW

1. **Oral communication**
   • Achievement of a presentation;
   • Achievement of an interview;
   • Response to an interview;
   • Representation of a record; oral
   • Summary of a text;
   • Achievement of a role play or simulation;
• Initiation to the leadership and to the dynamics of the groups;  
• Listening and Reading attentive of audio documents and or graphics.

2. **Achievement of a written message**  
• Taking of notes;  
• Administrative correspondence and professional (note, record, minutes, letter, CV, etc.);  
• Private correspondence;  
• Preparation of a survey;  
• Design and realization of a slogan and an advertising message etc.;  
• Drafting of instructions of use, security, standardization, etc.;  
• Drafting of a leaflet;  
• Drafting of a French composition;  
• Methodology of the drafting of a report on the training, etc.

3. **Study of the communication situations**  
• Identification of the factors in the situation of communication (issue, receiver, code, channel, message, context);  
• Situation of communication and verbal interaction (utterance);  
• Study of the elements para verbal cues (kinesthetistic, proxémiques, MIMO-gestural;  
• Identification and handling of figures of expressions and thoughts (metaphors, irony, satire, parody, etc.).

4. **Typology of texts and documentary research**  
• Reading of the texts of various nature (literature/non-literary, FIXED IMAGE/IMAGE mobile, drawing of press, caricature, etc.;  
• Analysis of advertising texts and speeches (scientific, policy, Literary, etc.);  
• Constitution and operation of a documentation and mounting of folders;  
• Readings of texts cultivating the moral and civic values.

Legal environment: 2 credits (30 hours); L, T, PW

1. **General introduction to the right**  
• The concept of law;  
• The characters of the rule of law;  
• The sources of the law (the hierarchical standards);  
• The application of the Act (the non-retroactivity of the Act and the territorality of the law);  
• The judicial institutions (courts, a principle of a double degree of jurisdiction, appeal in cassation);  
• Sanctions for violation of the rule of law (inhibition, execution, repair, repression).

2. **Labor law**  
• The sources of labor law;
• The different labor contracts (conventional contracts and precarious contracts);
• Execution of the work contract (payment of salary and claim of salary, different professional sanctions);
• Dismissal and resignation;
• Resolution of disputes in respect of work.

✓ ACR 127: Business creation and civic education and ethics

➢ Business creation: 1 credit (15 hours); L, T, PW
  1. Concept of contractor
  2. Motivations to the creation of a business
  3. Search for ideas and Evaluation
  4. Research Funding
  5. Choice of legal status
  6. Ethical aspects of business

➢ Civic education and ethics: 2 credits (45 hours); L, T, PW
  The Concepts
  • The citizen;
  • The Nation;
  • The State;
  • Publics Property and collective’s goods;
  • The freedoms;
  • The public service;
  • Ethics;
  • Ethics, Law and reason;
  • Ethical Problem ;
  • Ethics and management.
  • Civics
  • Deontology
  • Moral consciousness
  • The universal declaration of Human Rights
  • Good governance in public services
  • The importance of civics to the life of the nation
  • Functions of the state and its citizens
  • Deontology, Professional ethics and professionalism
  • Relationship between morality, law and ethics
  • Codes of ethics

✓ ACR231: Mathematics III

➢ Mathematics III: 4 credits (60 hours); L, T, PW
  Numerical Methods and Data Analysis
  1. Introduction
     • Magnitude of measurement, measured value and unit;
     • Definition of different types of errors;
• measurement uncertainties.

2. **Statistical methods**
   • Mean values and standard deviation;
   • Binomial distribution and distribution of fish;
   • Methods of calculations of errors: approximations and separation of values
     - Approximation by the method "Least Square" (least square fits);
     - Separation of values;
     - Approximation to from a polynomial;
     - Approximation of Lagrange.

3. **Fourier methods**
   • Fourier transform and TFF;
   • Auto correlation;
   • cross-correlation.

---

**ACR241 Mathematics IV**

- **Mathematics IV: 4 credits (60 hours); L, T, PW**
  1. **Introduction**
     • Purpose and objective of numerical methods.
  2. **Polynomial integration**
  3. **Digital integration**
  4. **Root of a function**
     • dichotomy;
     • Newton-Raphson;
     • Secant
  5. **Digital methods of algebra**
     • Gauss-Jordan;
     • Cholesky;
     • Decomposition;
     • Jacobi;
     • Gauss-Seidel;
     • Fadeev-Leverrier.

---

**ACR232: Physics and Chemistry II**

- **Physics III: 3 credits (45 hours); L, T, P, PW**
  1. **Thermodynamics**
     • Temperature and thermal expansion;
     • Heat and fundamental principle of thermodynamics;
     • Change of state of a gas ideals;
     • Kinetic theory of the heat;
     • Cyclic process : 2th fundamental principle of thermodynamics;
     • change of state;
     • Spread of the heat.
2. Electrodynamics and applications:
   • Currents and fields;
   • Production of magnetic fields;
   • The induction phenomenon;
   • Alternating current;
   • Electromagnetic waves.

➢ QSHE Base: 2 credits (30 hours); L, T, P, PW

A. Quality
   1. Quality and governance of information systems
      • Security of Information and ISO 27001;
      • Identity and Access Management;
      • Business continuity plans, contingency plans it.

B. Hygiene

C. Safety
   1. Electrical safety
      • Risks associated with the electrical current;
      • Instructions to apply and reflexes to have;
      • Care to injured persons after electrical shock.

   2. Ergonomics of the work station
      • The risks related to the work on screen, myths and realities;
      • The reduction of risks by the development of the position of
        the work and tasks.

   3. Health and Safety at Work
      • The issues, human, social, economic and legal;
      • The mechanisms at the origin of an accident at work;
      • Notions of basis for the health and safety at work;
      • Evaluation and control of risks in business.

D. Environment
   1. Eco-ICT, alias "Green IT"
      • Position of the problem;
      • Possible actions at the level of the datacenter;
      • Possible actions at the level of the machines;
      • Possible actions at the level of the network;
      • Among the particular.

   2. Protection of the private life
      • Definitions;
      • Basic principles;
      • Technologies for the protection of the private life.

   3. Electromagnetic Risk
      • Basic concepts;
      • Electromagnetic environment;
      • Electromagnetic compatibility;
      • Exposure of people to electromagnetic fields.
ACR242: Computer Science II

- Computer Science II: 5 credits (75 hours); L, T, P, PW
  1. **Border" machine (Hardware) - Man (Software)" as solutions to problems**
     - The bios;
     - The systems of applications;
     - The programs of applications.
  2. **Operating the machine and examples of operating system; WINDOWS (DOS);**
     - Linux: an interesting alternative.
  3. **A few examples of application software:**
     - The "Package Microsoft Office";
     - The software of navigation and search engines on the Web.

ACR 233: CAD and DAO

CAD and DAO: 5 credits (75 hours); L, T, P, PW

A. First part
  1. Introductory remarks and framing
  2. Choice of the CAD software and practical information
  3. Presentation and description of the Software
  4. Management of Information Created
  5. Study and taken in hand in the different modules
  6. Applications and realization of a mini-project

B. Second part
  1. Basics of technical drawing
  2. Modes of representation: projections, perspectives
  3. Study of the symbols of the refrigerated facilities: reading of refrigerated diagrams
  4. Representation of Piping Isometric perspective
  5. Basic Concepts in drawing building
  6. Representation of the air ducts
  7. DAO : the bases of Autocad
  8. DAO : the bases of Visio

ACR243: Materials

- Technological materials: 3 credits (45 hours); L, T, P, PW
  1. **Constitution and properties of the material**
     - Constitution of the atom, periodic table of the elements and chemical bonds;
     - Physical state of the material;
     - Crystalline solids, crystalline defects, amorphous solids; electrical properties.
  2. **Metals and metal alloys**
     - Crystal structure of metals;
• The properties of metals (mechanical, thermal and electrical);
  Applications.
3. **The semi-conductors**
   • Semiconductor materials;
   • Semi-conductors extrinsic and intrinsic;
   • Spatial and temporal variation in the concentration of the bearers of burdens;
   • Effects galvano-magnetic and electrical galvano.
4. **Dielectric materials**
   • Introduction
   • Electrical properties, electrical conductivity and electrical polarization;
   • gases;
   • The liquids;
   • The dielectric the inorganic and organic;
   • Ferroelectric Materials, pyroelectric and piezoelectric.
5. **Magnetic materials**
   • Magnetic properties;
   • Atomic Causes of magnetism;
   • Ferromagnetic Materials ferrimagnetic;
   • permanent magnet and magnetostriction.
6. **The superconductors**
   • Definition and Characteristics;
   • Applications.
7. **Components magnetic galvano and Resistors**
   • Introduction (component liabilities and assets, properties of resistors);
   • Constant resistors and variable resistors;
   • Driver to hot;
   • The components galvano-magnetic.

---

**ACR234: Work Practices**

- **P cold and air conditioning: 5 credits (75 hours); L, T, P, PW**
  1. The Shaping of copper tube
  2. Oxyacetylene welding and electrical arc
  3. Use of the manifold valves and valves for services for various operations on fluidic circuit
  4. Diagnostic elements and troubleshooting refrigerated facilities
  5. Use of the apparatus of control, regulation and security: Installation, adjustment, calibration
  6. Methodology of installation or commissioning of refrigeration systems
  7. Methodology of intervention and maintenance of refrigeration systems
8. Techniques of management of construction in cold and air conditioning
9. Manipulation on model: Taking the performance of a refrigerating installation
10. Manipulation on Model: studies of heat exchangers
11. Manipulation on Model: Measurement of the quantities of heat
12. Manipulation on Model: Study of the hydraulic pumps and losses of loads

❖ ACR244: Electricity and technology of refrigerated facilities

➢ Applied Electricity to cold: 2 credits (30 hours); L, T, PW

1. Reminders of mathematics
   • Complex numbers;
   • Vector calculation;
   • Definition and Description of a field.

2. Electrical Quantities and fundamental laws
   • The electrical load;
   • The Coulomb's law;
   • Intensity of the electric field;
   • Intensity of electric current;
   • The voltage and electrical potential;
   • Electrical resistance;
   • Conductance and Ohm's law;
   • Density of the electrical current;
   • Electrical power and power density.

3. Electrical Circuits simple
   • The laws of Kirchhoff;
   • Bipolar circuit equivalent;
   • Electrical Circuit of base (CEB);
   • Circuits with the dipoles non-linear;
   • Applications of laws of Kirchhoff;
   • Transformation of the power in a CEB.

4. Dependent variables of the time
   • Classification;
   • Periodic quantities.

5. Magnetic Circuits
   • Sizes fundamental magnetic;
   • Law of the magnetic current;
   • Calculation of magnetic circuits;
   • Law of induction.

6. Accumulator of electrical energy
   • the capacitors;
   • The coils.

7. Calculations with the complex in the techniques of alternating current
   • Introduction;
   • The complex vector;
• symbolic method;
• Calculation of alternative circuits.

8. The alternating current
• Power quantities and equations of definition;
• Complex representation of the alternative power;
• Compensation of reactive power;
• Measurement of the power of the alternating current.

9. The three phase current
• Circuits of basis;
• Power of the 3 phase power.

10. Dependence of the circuits of the frequency
• General Information;
• Dependence of the dipoles in the frequency;
• Dependence of the quadrupoles in the frequency;

11. Transient behavior of the electrical networks
• Problem Situation;
• Transient phenomena in the case of the continuous current;
• Transient phenomena in the case of the sinusoidal excitations.

12. The networks with sizes Non Harmonic
• average values and evaluation of quantities Non Harmonic;
• influence of fundamental components R, L, C;
• influence of components not linear.

➢ Technology of refrigerated facilities: 4 credits (60 hours); L, T, PW

1. The compressors
2. Condensers and cooling towers
3. The evaporators
4. The power supply units of the evaporators (regulators)
5. Apparatus annexs, regulation and security
6. Piping and Valves

➢ ACR235: Refrigerated warehouse and installation

➢ Refrigerated warehouse and installation: 4 credits (60 hours); L, T, PW

1. General information on the warehouses
2. Construction of a warehouse
3. Calculation of refrigerated loads
4. The design and sizing of refrigeration systems and equipment of a warehouse
5. Thermal insulation of the warehouses
6. Furniture refrigerated showcases
7. Refrigerated Transport

➢ ACR245: Refrigeration Conservation

➢ Conservation cold: 3 credits (45 hours); L, T, PW

1. The techniques of conservation by the heat
2. The techniques of conservation by the cold
3. The techniques of conservation by separation and removal of water
4. The techniques of conservation by Food Additives
5. The techniques of conservation by fermentation

**ACR236: Production of the cold**

- production of the cold: 4 credits (60 hours); L, T, P, PW
  1. Thermodynamic Reminders
     - 1, 2nd principles;
     - Cycles;
     - Thermodynamic diagrams.
  2. The production techniques of the cold
  3. Study of the cycles to mono compression storied
     - Compression
     - Thermal exchanges;
     - Relaxation;
     - Overheating;
     - Under cooling, yields.
  4. Study of the cycles to multi compression storied
  5. The refrigerating machine to absorption

**ACR246: Professional internship**

- Professional Internship: 6 credits (90 hours); P, PW
  1. Arrival and Business Integration
  2. Working in a company
  3. Holding of the Intern journal
  4. Choice of the theme of work in collaboration with the professional picture framer and the academic framer
  5. Elaboration of the canvas of research
  6. Resources to exploit
  7. Organization of work
  8. Drafting of the report
  9. Presentation of the report before a jury

**ACR237: Methodology of drafting internship report**

- methodology of drafting of the IR: 3 credits (45 hours); L, T, PW
  A. Drafting and structuring of the probation report
     1. General Approach
        - Nature and contents of the report of internship;
        - Paragraph;
        - The style and spelling.
     2. Structuring of the document
        - Coverage;
• Acknowledgments;
• In-head of the probation report;
• Executive Summary;
• List of Figures and list of tables;
• Glossary;
• Body of the report of internship;
• Bibliography;
• Annexes;
• Summarizes and keywords.

B. Formatting of the probation report

1. General information
   • Remission of the probationary report;
   • choice of software.

2. Rules of presentation
   • Size of the probation report;
   • Page layout;
   • Families of fonts;
   • Sizes and styles of fonts;
   • spacings
   • pagination.

3. Notes at the bottom of the page

4. Floaters
   • Tables;
   • Figures;
   • List of Figures List of tables;
   • equations;
   • Glossary.

5. Bibliography
   • Purpose of the bibliographic citations;
   • Format of bibliographic citations; pop-up
   • List of bibliographic references;
   • Bibliographic references for the electronic documents.

acr247: Accounting and Economics

➢ Accounting: 1 credit (15 hours); L, T, PW

A. General Ledger

1. The Company and its heritage
   • Concept of enterprise;
   • Balance sheet and its variations.

2. Analysis of the current operations of the company
   • Notion of jobs resources;
   • The Accounting transfer;
   • accounts to the balance.

3. The operations of purchases and sales
   • Invoicing;
   • Accounting registration;
• system of inventory;
• plug of stock.

4. The regulations on term: the effects of trade
   • Definitions
   • Principles
   • Calculations

5. The depreciation and amortisation
   • Definition;
   • Accounting registration;
   • typology.

B. General introduction to the Financial Analysis

1. Analysis of the balance sheet
   Presentation Summary of the balance sheet.

2. Study of the structure of the balance sheet
   • Calculations of ratios.

3. Functional analysis of the balance sheet
   • Definition;
   • Principles;
   • Computations;
   • Table of exploitation functional.

4. Differential analysis of the balance sheet
   • Definition;
   • Principles;
   • Computations;
   • Table of exploitation differential.

C. Analytical accounting of management

1. Generality on the cage
   • Objective;
   • Role;
   • Concept of Load.

2. Analysis of expenses
   • Liable loads;
   • Direct expenses, indirect;
   • Valuation of stocks.

3. Method of full costs
   • Cost of purchase;
   • Cost of Production;
   • cost of returns;
   • Calculation of the result.

➢ Economy: 2 credits (30 hours); L, T, PW

1. Notions of general economy
   • Introduction;
   • The consumption and production;
   • The training of income;
   • The currency and credit;
• The prices;
• The concept of growth and development.

2. **The Company**
• Introduction;
• Typology of enterprises;
• Structure and organization of the enterprise;
• The Company and the ethics;
• How to undertake (Create, decide, manage).

3. **The place of the company in the economic fabric**
• Concept of the environment of the company;
• The relations inter- and extra-enterprises;
• the commercial activity;
• Notion of strategy.

4. **The productive activity**
• Policies and processes of production;
• Trade policies;
• Logistics.

5. **The concept of management in the company**
• The activity and financial resources;
• The planning and management of human resources;
• The planning and the management of hardware resources.

6. **Information and Communication in the Enterprise**
• Role of Information and communication;
• Collection and organization of information;
• strategic diagnosis;
• Decision system
Field: THERMAL AND ENERGY ENGINEERING

Specialty:

SUSTENABILITY AND RENEWABLE ENERGY
1. The objective of the training

The primary objectives of the higher professional diploma (HPD) programme in Sustainability and Renewable Energy Technology are:
- To produce competent professionals with key skills adequate to solve practical problems relating to Sustainability and Renewable energy Technology in both the Public and Private Sector businesses and Not-for-Profit organizations,
- To enhance students' knowledge and practical skills in generating new energy and sustainability technologies
- To increase knowledge through conduct of basic, and adaptive research.

2. Research Skills

   → Generic skills
   - Work in autonomy, collaborate as a team;
   - Analyze, synthesize, a professional document (French, English);
   - Communicate to the oral, written, in business or outside (French, English);
   - Participate in /conduct an approach to the management of the project;
   - Know and exploit the professional networks and institutional sectors of the electricity.

   → Specific skills
   - Make an electrical installation (production, transport networks and the distribution of the energy);
   - Manage the aspect technico-economic electrical networks;
   - Conduct and carry out a project;
   - Perform the maintenance work and maintenance in the electrical networks.

3. Employment Opportunity

Upon completion of the training, graduates can aspire for the following responsibilities and job opportunities in both the Public and Private Sector businesses, and Not-for-Profit organizations:
- Sustainable solution officers;
- Sustainable energy officers (engineers and technicians);
- Sustainable energy manager/analyst/specialist.
- Leader of photovoltaic project;
- Developer of projects in renewable energy;
4. Organization of the Teachings

**YEAR ONE  1ST SEMESTER**

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**Fundamental courses 30% (2 UC) 9 credits 135 hours**

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**Professional courses 60% (4 UC) 18 credits 270 hours**

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**Transversal courses 10% (1 UC) 3 credits 45 hours**

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**Fundamental courses 30% (2 UC) 9 credits 135 hours**

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**Professional courses 60% (4 UC) 18 credits 270 hours**

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**Transversal course 10% (1 UC) 3 credits 45 hours**

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**Total**
# YEAR TWO 3RD SEMESTER

**Field of study:** Thermal and Energy Engineering  
**Specialty:** Sustainability and Renewable Energy

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# YEAR TWO 4TH SEMESTER

**Field:** Thermal and Energy Engineering  
**Specialty:** Sustainability and Renewable Energy

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<td>Civic Education and Ethics, And Entrepreneurship</td>
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</table>
5. Course content

❖ SRE111: Engineering Mathematics I

Objectives: At the end of this Course the Student Should Understand basic equations-master Numerical Methods solve Statistical problems
1. Linear equation, differentiation ,integration, geometric equations
2. Differentiation: Rolle’s theorem and the man-value theorems, Taylor’s theorem, Repeated Differentiation, Applications for Differentiation, Indeterminate form; Vector algebra and its application.
4. partial differential equations, boundary value problems.

❖ SRE 112: Engineer in the society

1. Introduction
2. Historical evolution of engineering
3. Career orientation on various engineering fields
4. Initiation and interpretation of administrative letters
5. Engineering and environmental pollution
6. Managing change
7. Organizational behavior, positive self talk, managing stress
8. The industry and industrial psychology
9. Engineering contracts
10. Tendering for public contracts
11. Specifications writing
12. Law (tort, contract)
13. Organizational set up
14. Setting up an enterprise

❖ SRE 113: Environmental Policy & Ethics

➢ Environmental Policy

Course & Objectives:
This course is an introduction to currently relevant domestic and international environmental policy. Topics include the scientific fundamentals for existing environmental regimes, environmental economics, the environmental law itself and some discussion of application. It explores policy responses to significant local and global environmental problems, such as biodiversity loss, fisheries, clean air and water, and climate change. The central purpose will be to build literacy and analytical capacity for the existing portfolio of environmental regimes, both domestic and international.
➢ Ethics

Objective: This course examines the morality of our treatment of the environment. Investigate questions of ethical theory, such as: Do we have moral obligations to animals, plants, species, and ecosystems? And do we ever have a right, or duty, to harm or kill some human or nonhuman animals in order to benefit or save others? Apply these ideas to environmental questions, such as: Do we have a duty to conserve or preserve natural resources or the wilderness? And do we have a duty not to contribute to pollution or climate change?

❖ SRE114: Sustainability, Population and Sustainable Development Practices,

Objective and Content:

This course will introduce students to sustainability and provide students with skills in attaining sustainable development and an understanding of the assumptions involved in projecting population trends. It will also provide an overview of the causes of changing population trends and discuss their implications. It will review the models used to assess the impact of population trends on the environment, including some of those used by the International Panel on Climate Change. Lastly, it will discuss whether and how population policy can contribute to attain sustainability.

❖ SRE 115: Evolution & Ecology

Objectives & Content:

This course explores the history of evolutionary thought and science to gain a conceptual overview of evolution. Learn how and why species change over time, why some species survive while others go extinct, and what modern genetics may reveal about human evolution. Basic concepts in ecology which include ecosystem, energy flow, food chain/food web, trophic level, biogeochemical cycles, diversity, carrying capacity, limiting factors and ecological succession. Basic principles in sustainable development, six tests of sustainability’s in the projects level and pillars of sustainable development.

❖ SRE116: Science & Policies of Climate Change

Objective:

The course aims to introduce the underlying science of human-induced and naturally-occurring climate change, examines predictive models of climate change and projected impacts.

Content:
Climate change impacts and adaptation, climate prediction models, feedback processes and uncertainties, costs and benefits of climate change impacts, adaptation and response measures, relationship between climate change science, policy and economics; existing policies (Kyoto Protocol and IPCC reports), other possible technological, economic and command-and-control options, potential policies to deal with consumption and population growth.

**SRE117: French language and computer for business I**

- **French language**

**Objectives**: At the end of the unit the student should master Communication Skills in french

**Contenu**
A la fois thématique et morphosyntaxiques, l’accent sera mis sur :

1. La grammaire ; Les variétés de français ; La communication ; La vie de l’entreprise L’étude et la production de textes Supports nécessaires à l’atteinte des objectifs
2. La lettre ; Le rapport ; Les textes littéraires ; Les coupures de journaux ; Compte rendu écrit ou oral des visites d’ateliers ; Textes descriptifs et narratifs ; Les exposés ; Les débats, etc....
3. De la phrase au paragraphe : Noms, pronoms, verbes, conjonctions de coordination, adverbes, prépositions ; Etude de texte en tant qu’unité courante et autonome Exercices d’expression libre ou semi guidée à partir d’un sujet donné, en réaction à un document ou à partir d’un modèle en travail de groupe ou individuel. L’enseignement se fera à partir des thèmes déclencheurs tels que des sujets d’actualité pouvant faciliter la prise de parole et la communication, d’articles de journaux, magazines, courriers, publicités, communiqués, etc.

- **Computer for business I**

1. Generalities, impact of computer on society, current notions, basic hardware, software and networking
2. procedures in using computer systems
3. Practical approach – hands-on - Ms word -Ms excel -MSpowerpoint - Ms access

**SRE 121: Engineering Mathematics II**

Finite differences: Difference tables, forward, backward and central differences; Linear systems: Matrix methods, Gaussian elimination. Gauss-Seidel, ill-conditioning; Errors: Sources, estimates, propagation, floating point arithmetic; Operators; Curve fitting; Interpolation: Lagrange, Newton’s forward and backward; Euler and Runge-Kutta methods; Collation polynomials; Newton-Raphson.
Statistics and Probability
Introduction to probability; Random variables and functions of random variables; Mathematical expectations and moments; Special discrete and continuous distribution: binomial, exponential, gamma, chi-square, t- and F- sums of random variables Law of large numbers; Central limit theorem

SRE 122: Fluid Mechanics
Fundamental concepts in fluid mechanics; Characteristics and properties of fluid; Fluid statics: Basic equation of hydrostatics, pressure distribution in a static and constant accelerating fluid, hydrostatic force on plane and curved surfaces immersed in static fluid, floating bodies and buoyancy, continuity equation (differential and integral form); Kinematics of fluid motion: Velocity, acceleration, streamlines, stream-tubes, particle paths, streak lines; Definition of irrotational and rotational flow; Circulation; Stream function and velocity potential function for flow in a uniform stream and due to source, sink and doublet and for simple combinations of these.

SRE 123: GIS and Remote Sensing
Objective and Content:
This course focuses on the GIS principles, methods, and techniques relevant and useful for problem solving in environmental analysis and management. It looks at GIS principles; data models, scale and spatial sampling, and spatial autocorrelation; a review of the major techniques or issues for environmental data acquisition and integration; an introduction to environmental analysis and modelling techniques; environmental modelling techniques as related to landscape ecology, hydrology, natural hazards, natural resources management, and environmental planning.

SRE124: Introduction to EIA
Objective: To introduce the students to EIA, the methodologies and approaches that can be used for impact assessment and to drill students on project management and working in a team

Content:
Goals, principles, purpose, functions of EIA. EIA in development planning, EIA process and role of EIA in project development. Legal and administrative frameworks, EIA procedural flow, Cameroon EIA System, Environment Compliance Certificate (ECC), public participation in EIA.
**SRE125: Environmental Research Methods**

**Objectives and Content:**
This course introduces students to basic research methods and internship reporting. It includes; sampling techniques and procedure, various techniques statistical analysis of data including some software programs. It also looks at guides to report research, internship and experiments. Finally it trains students on proposal writing.

**Content**
- **Initiation to research: 1 credit (15hours); L, T, P, SPW**
  1. In Health Research
  2. Sources of Knowledge
  3. Methods of Reasoning
  4. Stages of the research process (rational, assumptions, literature review, methodology, results/discussion, summary, bibliography)
  5. Classification of research
  6. Establishment of the Questionnaires
  7. Ethics
  8. Preparation and Presentation of Research Reports
  9. Case practice; drafting of protocols of research
- **Construction of a Research proposal: Background: Literature review,** formulating the problem statements, justification of studies, objectives, framing the questions according to general and specific objectives; is developing a testable hypothesis to achieve the objectives for quantitative research selection, referencing, etc.; Ethical considerations; Work plan: personnel; timetable project administration; Plans for dissemination.

**SRE126: Short Internship Report**

**Objective:** To enable the student to: be acquainted with the industrial milieu, acquire more knowledge experience in a different environment

**Content:** Industrial integration. The student is followed up during this period both by a senior instructor in the industry and an academic supervisor.

**SRE 127 : Communication Skills and computer programming**

The course focuses on English grammar and is a required course for first year students. Students will be assisted to review some of the common problem areas of their writing, such as verb/tense system, concord, as well as other problem areas to be identified by the lecturers in charge.
Basic grammatical structures that involve teaching students to write formally correct sentences, avoiding sentence errors, and using punctuation effectively.

The course is also designed to continue the process of helping students to become better writers. The first part of the course will focus on writing skills – paragraphs, and then essays. Students shall also study the preparation of technical documents such as memos, reports, letters and proposals.

➢ **Computer Programming**

Generalities on Programming, Delphi and Visual Basic Programming: Visual Basic concepts, Designing programs, Program Flow, Testing and Debugging, Functions, Arrays, Interacting with the user, Interacting with the system; Mastering of professional Software; Algorithms

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**SRE 231: Engineering Mathematics III Legal and economic environment**

➢ **Engineering Mathematics III**

1. Matrix theory, differential calculus
2. First order differential equations
3. Linear differential equations of higher order
4. Laplace transformation, integral calculus, vector calculus
5. Fourier series and transformations, Z-transform, partial differential equation,

➢ **Legal and economic environment**

1. Introduction to law
2. Fundamental rights
3. Cameroon political history, re-unification, division of power, political and administrative institutions
4. The democratic process, political parties, civil society, pressure groups, local government, nation building, government budgeting
5. Managing debt crises, foreign aids, foreign policy, Cameroon and her neighbors, politics and trade

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**SRE232: Computer for business II**

Contents

1. Revision on; -ms word  -ms excel  -ms powerpoint  -Ms access
2. Office automation
3. Graphics and graphing packages
4. Internet working
5. Information services
SRE233: Life Cycle Assessment & Scenarios for Sustainable World

- **Life Cycle Assessment**

**Objectives and Content:** This course is designed to give an essential overview of life cycle assessment in relation to sustainable energy consumption. It will help you to interpret and evaluate LCA studies and to understand the strengths and weaknesses of LCA. It looks at LCA from background, methods & standards, environmental indicators, data and tools, fate modelling and interpreting results and case studies.

- **Scenarios for Sustainable World**

**Objective and Content:** This course addresses the role of governments and business in archiving sustainability. This course addresses key questions such as: Can finance and investing be a part of the solution? How can companies be more involved to drive solutions and what are they already bringing to the table? What role do governments and other global bodies have to play? What happens if we do nothing or instead choose only incremental change as a way forward? What does dramatic change look like? Do we now need to consider dire choices? And what are they?

SRE234: Renewable Energy and Bio-waste Management Technology

**Objective & Content:**

This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The class will explore society’s present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized.

SRE235: Energy & Sustainability cities

**Objective & Content:**

This course examines the evolution of issues, attitudes, and policies surrounding energy production and use through time, and provide a critical examination of current trends in consumption, production, and potential future sources of energy. Technologies, philosophies and policy approaches, as well as the current accepted thinking on the topic will be evaluated to enable participants to ask new questions and derive innovative ideas and approaches to address this prominent global issue through readings, research, and discussion.
**SRE236: Sustainability Practices**

**Objective:** The objective of this course is to provide students an opportunity to understand current environmental and marine issues and practices, to appreciate the importance of developing sustainable environmental practices, and eventually build their own overall picture of environmental and marine activities.


**SRE 237: French II and General English**

At the end of the unit the student should master Communication Skills in English master Communication Skills in French

- **French II**

**Contenu:** A la fois thématiques et morphosyntaxiques, l’accent sera mis sur :

1. La grammaire
2. Les variétés de français ;
3. La communication ;
4. La vie de l’entreprise
5. L’étude et la production de textes
6. Supports nécessaires à l’atteinte des objectifs
7. La lettre ;Le rapport ;Les textes littéraires ;Les coupures de journaux ;Compte rendu écrit ou oral des visites d’ateliers ;Textes descriptifs et narratifs ;Les exposés ;Les débats, etc. ;
8. 
9. Rappels du contenu du premier semestre
10. Le nom : pluriel des noms, noms simples, cas particuliers
11. Le verbe : Temps composés choix, temps de l’auxiliaire. Avoir, Etre au présent, future, plus que parfait et passe simple du mode indicatif
12. La synonymie et l’Antonymie
13. Définition et exercices d’application
14. L’Adverbe : Typologie et formation
15. Exercices de suivi relatifs awk 2-5
16. Le nom pluriel :
17. Cas particuliers
18. Noms composés
19. Simples, 1 structure règles exercices
20. Le verbe : Temps composés
21. Le participe passés : sa forme, verbes du 1er, 2eme, et 3eme groupes
22. L’Homonymie, définition exercices d’application
23. Le verbe : la participe passé : sa forme, son accord : avec Etre
24. Le verbe : Accord avec Etre, avec avoir  
25. Le participe présent des verbes  
26. Compréhension de texte : notions (concepts) relatives à l’option(s)  
27. Evaluation continue

➢ English

1. Types of discourse: expository, descriptive, narrative  
2. Note taking (in lectures, in meetings)  
3. Turn taking conversational English  
4. Basic techniques of reading  
5. Basic techniques of writing  
6. Formal and informal letters  
7. Application for a job  
8. Administrative letters  
9. Invitations  
10. Writing CV  
11. Writing minutes of meetings  
12. General characteristics of the language in accordance with the area of specialization  
13. Technical writing  
14. Writing technical report  
15. Writing projects  
16. Writing technical instructions  
17. Summarizing documents  
18. Techniques in public speaking  
19. Techniques of negotiation

❖ SRE241: Environmental Sustainability & Decision Making

Objectives and Content:

This course addresses how innovative corporations are beginning to address environmental issues from a business perspective: minimizing associated costs and risks and capturing business opportunities to improve competitive advantage. The course focuses on ecosystem service valuation as an effective tool that corporations are using to assess company-specific environmental footprints, identify approaches to effectively reduce impacts, and to bring this information to the marketplace as a means of product differentiation to secure existing markets and facilitate access to new business opportunities.

❖ SRE 242: Engineering Mathematics IV

1. Complex variables and mapping,  
2. Special functions (bessel function, splines and legendre)  
3. Statistical and numerical methods, statistics and probability  
4. Numerical analysis, series and sequences, linear programming
**SRE243: Urban Resilience and Strategies for an Eco-Economy**

**Objective & Content:**

This course examines the connections between environmental sustainability, resilience, and the need and ability to compete in a global marketplace. It begins by defining “urban resilience” and the “eco-economy,” exploring the competitive realities that exist in human driven systems. The course also analyses the need for "org-ware" developers and “future system integrators” – those professionals who connect the dots between data, intelligent design, resilience, and sustainable communities to achieve a distinct competitive advantage in the 21st century.

**SRE244: Design of Solar and Wind Hydro power Systems**

**Objective:**

To introduce students to the use of renewable sources of energy, more specifically drill them on the design of solar, wind and hydropower systems

**Content:**

Introduction to renewable energy sources: wind energy, hydropower, solar energy (photovoltaic systems, solar thermal systems (power plants, solar water heating), solar cooling), wind energy systems (wind turbines generating electricity, grid-connected wind turbines, stand-alone wind turbines, wind turbines for water pumping), hydropower systems; (operation principle of the different technologies; design considerations; design calculations).

**SRE245: Case Study**

This course ensures that participants receive practical, hands-on training in applied sustainability and renewable energy skills. Offerings include field courses and independent courses.

**SRE246: Long Professional Internship Report/Defence**

**Objective:**

This course is to provide an opportunity for students to undertake an in-depth research investigation in one of the areas covered by the Programme and Specialization.

**Content:**

Final year students will carry out project work. The project should belong to on or more of the following areas: computing and analysis; design; laboratory investigation; field testing and instrumentation; case studies. The project duration is over the entire
second semester. An individual formal report is required. Each student is required to make an oral presentation.

**SRE 247: Civic education and Ethics, and Entrepreneurship**

- **Civic education and Ethics**: 2 credits (30 hours); L, T
  
  **The Concepts**
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem;
  - Ethics and management.
  - Civics
  - Deontology
  - Moral consciousness
  - The universal declaration of Human Rights
  - Good governance in public services
  - The importance of civics to the life of the nation
  - Functions of the state and its citizens
  - Deontology, Professional ethics and professionalism
  - Relationship between morality, law and ethics
  - Codes of ethics

- **Entrepreneurship**: 1 credit (15 hours)
  1. Generalities on enterprise
  2. Wealth creation and how to make money
  3. Evaluate the state of enterprise
  4. Analyses of the activities of enterprise
  5. Analyses of the cost effectiveness of an enterprise
  6. Analyses of the structure of an enterprise
  7. Analyses of the treasury of an enterprise
  8. Budgeting
  9. Elements of analytical accounting and management
  10. Creating an Enterprise
  11. Business plan
Field: THERMAL AND ENERGY ENGINEERING

Specialty: MAINTENANCE AND MANAGEMENT OF FLUID SYSTEM
1. The objective of the training

The training of senior technicians in the maintenance of energy systems and fluidic systems ensures the proper operation of the facilities in the varied applications such as heating, air-conditioning, the cold, the Sanitary and systems of renewable energies (cogeneration, heat pumps, etc.).

2. Research Skills

- **Generic skills**
  - Work in autonomy, collaborate as a team;
  - Analyze, synthesize, a professional document (French, English);
  - Communicate to the oral, written, in business or outside (French, English);
  - Participate in /conduct an approach to the management of the project;
  - Know and exploit the professional networks and institutional capacities of thermal sectors.

- **Specific skills**
  - Understand the technical characteristics and the modes of operation of the systems and facilities heat and energy;
  - Understand the physical phenomena which are associated with them;
  - Determine their performance and limitations of operation;
  - Understand, apply and enforce the standards and regulations in force and the safety rules specific to each installation.
  - Participate in the expertise of a installation (inventory hardware, analyze malfunctions, assess the states of obsolescence);
  - Intervene on facilities (perform surveys, implementing procedures, perform tests, carry out adjustments);
  - Participate in the organization of the maintenance (establish operating range, establish a schedule, achieve and inform a workbook for monitoring, analyze of the status indicators and their drift, develop a logbook); design the technical solutions;
  - Proposing changes to the installation and the Encrypted solutions leading to improve consumption and the comfort;
  - Analyze the functioning of a well, driving a well and optimize its operation;

3. Employment Opportunities

- Agent of development of renewable energies;
- Econome of stream;
- Technician maintenance in climate engineering;
- Technician of operation of the gas network;
- Geothermicien;
- Technician thermicien
- Responsible design, implementation and maintenance of cold storage facilities and climate.
4. Organization of the Teachings

**FIRST YEAR: FIRST SEMESTER**

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<td>MMF112</td>
<td>Physics and Chemistry I</td>
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<td><strong>Fundamental courses 30% (2 CU) 9 credits 135 hours</strong></td>
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<td>MMF113</td>
<td>Maintenance I</td>
<td>40</td>
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<tr>
<td>MMF114</td>
<td>Measurement, Metrology</td>
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<td>MMF115</td>
<td>Technology and Techniques in Thermal Engineering</td>
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<td>MMF116</td>
<td>Thermodynamics</td>
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<td>MMF117</td>
<td>Written Expression and Legal environment</td>
<td>22</td>
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**FIRST YEAR: SECOND SEMESTER**

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<td>MMF122</td>
<td>Physics and Computer</td>
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<td>Mechanical and Mechanical waves</td>
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<td>MMF124</td>
<td>Fluid Mechanics</td>
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<td>MMF125</td>
<td>Distribution of electrical energy and electricity</td>
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<td>MMF126</td>
<td>Thermal transfers and Maintenance</td>
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<td>MMF127</td>
<td>Accounting and Economics</td>
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<td>Physics and Chemistry II</td>
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<td>MMF233</td>
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<td>Technical studies and Personal Project</td>
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<td>MMF235</td>
<td>Fluids and networks</td>
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<td>MMF236</td>
<td>Achievement, implementation of procedures I and Regulation</td>
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## SECOND YEAR: FOURTH SEMESTER

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<td>MMF241</td>
<td>Mathematics IV</td>
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<td>MMF242</td>
<td>Computer Science II</td>
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<td><strong>Professional courses 60% (4 UC) 18 credits 270 hours</strong></td>
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<td>MMF243</td>
<td>Materials and conversion of energy</td>
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<td>MMF244</td>
<td>Maintenance II</td>
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<td>MMF245</td>
<td>Achievement, implementation of procedures II and business software, Energy and Environment</td>
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<td>MMF246</td>
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<td><strong>Transversal courses 10% (1 UC) 3 credits 45 hours</strong></td>
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<tr>
<td>MMF247</td>
<td>Creation of business and civic education and ethics</td>
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</table>
5. Course content

❖ MMF111: Mathematics I

➢ Mathematics I: 4 credits (60 hours); L, T, PW

1. Real Numbers
   • Ordered set, advancing, reduces, terminals upper and lower, maximum, minimum;
   • Concept of intervals;
   • Absolute value;
   • Integer part;
   • rational fractions;
   • Equations and inequalities.

2. Complex numbers
   • Algebraic Representation and module;
   • Trigonometric representation and argument;
   • Exponential representation and formula of Moivre;
   • Nth root of a complex;
   • Resolution of the equation of the 2nd degree in C;
   • Linearity, complex plan.

3. Digital suites
   • Definition;
   • Of converging suites (limits, increasing suites and increased, decreasing and demeaned); Suite and criterion of Cauchy;
   • arithmetic Suites and geometric;
   • theorem of Bolzano-Weierstrass.

4. Numerical Functions of a real variable
   • Reminders on the study of the relations in the ensembles: (definition of an application, applications injectives and subjective, concept of correspondence);
   • Domain of definition, limits and continuity;
   • Derived from the functions;
   • Table variations and graph functions;
   • The theorems of Rolle and formula of finished increases;
   • Rule of the Hospital, Taylor’s formula and Developments Limited.

5. Usual functions
   • Logarithm functions and exponential;
   • Trigonometric and hyperbolic functions.

6. Full calculations
   • Decomposition of rational fractions in simple elements on R;
   • Integration of rational functions and stair;
   • Calculation of the integrals and the concepts of primitive;
   • Integrable function within the meaning of Riemann;
   • Ultimate unfit; ultimate dependent on a parameter;
   • Derivation under the sign of the integral;
   • Generalized integrals;
• Introduction on applications to the calculation of length, area and volume.

7. **Digital series and series of Fourrier**
   • Digital series: Series to positive terms, absolute convergence, General theorems;
   • Suites and series of functions of one real variable: convergence simple, uniform convergence, normal convergence, General theorems; the entire series: Radius and interval of convergence, General theorems; Layout of curves in polar coordinates; Fourier series and exponential series.

❖ **MMF 121: Mathematics II**

➢ **Mathematical II : 4 credits (60 hours); L, T, PW**

1. **Algebraic Structures**
   • Sets, applications, relationships;
   • The items of the theory of numbers;
   • Introduction to the theory of groups;
   • Rings and body.

2. **Linear algebra**
   • Vector spaces;
   • Linear applications;
   • Matrix calculation (matrices, determinants, and applications, diagonalization, triangularisation, etc.);
   • System of linear equations;

3. **Boole’s algebra**
   • Introduction to Boolean logic;
   • Numbering systems;
   • Logical function and theorem of decomposition;
   • Simplification of Boolean functions;
   • Elements of Formal Logic;
   • Application to logical circuits.

4. **Real function to several variables**
   • Field of scalars, vector field;
   • Partial derivatives;
   • Multiple integrals (double and triple rooms);
   • Gradient of a scalar field, theorem of Gauss;
   • Divergence and rotation of a vector field, theorem of Stokes;
   • Calculation of curves and surfaces in the full space curved and surface);
   • Laplacian of a field of scalars and of a vector field.

5. **Function Theory**
   • Definitions and Introductory Study.

6. **Differential Equations**
   • Differential Equations 1 order;
   • Differential Equations of linear 2nd order with constant coefficients.

7. **Probability and Statistics**
• Calculation of probabilities;
• The laws of probability;
• Statistics and methods of estimation.

❖ MMF 112: Physics and Chemistry

➢ Physics I: 3 credits (45 hours); L, T, P, PW
  Mechanical
  1. Kinematics
     • Introduction;
     • Repository system and vector of position; speed and acceleration;
     Movement in the field of gravity.
  2. Action of the forces on a hardware point:
     • Principle of inertia and fundamental principle of the dynamic;
     • The superposition of the Forces;
     • The forces of inertia;
     • Friction and friction forces.
  3. The gravitation:
     • The force of gravity;
     • Law of gravitation;
     • fields of forces.
  4. Work, power, energy and amount of movement:
     • Work;
     • Power;
     • Energie;
     • Amount of movement.
  5. Action of the forces on a solid body:
     • Static;
     • Kinetics of solid bodies.
  6. Fluid Mechanics;
     • Fluid and gas in the rest;
     • Disposal of liquid incompressible.

➢ Chemistry: 2 credits (30 hours); L, T, P, PW
  1. Structure of Matter
  2. Chemical analysis
  3. Chemical Notation Introduction
  4. Chemical reaction and chemical equation
  5. The refrigerants
  6. The refrigerated oils
  7. Chemistry and the environment: impacts of fluids and substances used in
cold and air conditioning on the environment
  8. Food Microbiology
  9. Methods of conservation
  10. Optimal condition for the refrigerated storage
11. Conservation of animal and plant products

**MMF 122: physics and computer science**

- **Physics II: 2 credits (30 hours): L, P**

  **The Oscillations and Waves**
  1. **Kinematics of the oscillating body**
     - General information;
     - The harmonic oscillator;
     - Superposition of oscillations.
  2. **Dynamics of oscillating body**
     - The harmonic oscillator free;
     - Amortization;
     - Forced oscillations and coupled oscillations.
  3. **Air Waves**
     - General information;
     - Harmonic waves;
     - Transport of energy;
     - Groups of waves;
     - The superposition of the waves;
     - The reflection, refraction and diffraction of the waves;
     - Sound waves and ultrasound.

- **Computer Science I: 3 credits (45 hours): L, P, PW**

  1. **General information and vocabulary**
     - Concept of information and informatics;
     - Resolution of the problems by the informatics;
     - Typology and computer configuration;
     - Fields of application of informatics;
  2. **Representation and processing of the information**
     - Systems of numbers;
     - Representation of Numbers and Characters (coding of information);
     - Boolean logic;
     - Circuits of the calculations & memory;
     - Presentation and differences between digital data & non-numeric data.
  3. **Structure and operation of a micro-computer**
     - Architectures of micro-computers;
     - Functional units (Central Unit, Units of entry and exit);
     - Architecture and performance of microprocessors;
     - Schedule a micro-computer (programming binary, hexadecimal, languages of assembling and evolved);
     - Presentation and roles of the programs, their applications.
MMF 113: Maintenance I

- Organization of the maintenance I: 3 credits (45 hours); L, T, P, PW
  1. The maintenance assisted by computer
  2. Technique of preventive maintenance on parole
  3. Study of the behavior of the hardware
  4. Analysis of machines or specific facilities SR technical file, read plans
  5. Functional Analysis and Technology
  6. Kinematics analysis and technical support
  7. Technology and Thermal maintenance (component fluidic, Schematic And Circuits, maintenance and safety equipment, ...)

- Technical maintenance, conduct, Prevention I: 2 credits (30 hours); L, T, P, PW
  1. Abacus and decision tree
  2. Planning of the interventions of preventive maintenance
  3. The maintenance cost
  4. Cost of Maintaining a system
  5. Cost of corrective maintenance
  6. Cost of Preventive Maintenance
  7. Search for the optimum of the date of the intervention

MMF123: Mechanical and Mechanical waves

- Mechanical: 2 credits (30 hours); L, T
  1. Mechanical
    - Vector calculation and static;
    - Concept of torseur and basic operations;
    - Characterization of the mechanical connections;
    - Fundamental Principle of static solid and basic applications;
    - Kinematics;
    - Definitions: position, speed, acceleration of a hardware point;
    - Definition of the distributor torseur speeds of a solid;
    - study of a few simple movements plans on plan;
    - basic notions on the relative movement.
  2. Kinetics
    - Definitions: quantity of movement - kinetic energy;
    - Torseur kinetics of the solid holds its shape: definition, establishment in simple cases;
    - Theorem of the kinetic energy and basic applications;
    - Dynamic;
    - Torseur dynamics of the solid holds its shape: definition and establishment in simple cases;
    - Fundamental principle of dynamics;
    - Applications in relation to the thermal and energy.

- Mechanical waves: 2 credits (30 hours); L, T, PW
**MMF 114: measurement, metrology**

- **Measurement, metrology:** 3 credits (45 hours); L, T, PW

1. **The sensors**
   - Principles of operation;
   - Choice of the principle / choice of sensor;
   - Absolute sensors, relating, differentials;
   - Measuring range and sensitivity, dynamics of the sensor.

2. **The electronic packaging**
   - Current power supply / Voltage;
   - charge amplifier;
   - sensitivity.

3. **Concept of signal processing (in the context of the acquisition of data)**
   - Different types of signals;
   - Sampling;
   - The downturn of spectrum;
   - Scan;
   - Fourier analysis;
   - estimate of the DSP;
   - filtering.

4. **The uncertainties of Measures**
   - Reminders of probabilities;
   - Average, gap-type, duration of measurement;
   - The compositions of the errors;
   - Distribution function, density of probability;
   - Normal distribution, Student;
   - robust estimators;
   - histograms.

5. **Modeling of the measures**
   - Correlation between two random variables;
   - Regression of first and second species;
   - The Models: method of least squares, method of the chi-square;
   - Periodic effects;
   - Questionable measures;
   - Validation of the model;
   - Quality of the adjustment.

6. **Reference variables and calibrations**
   - Reference variables and transfer standard (for the magnitudes of the mechanical);
   - Calibration and digital acquisition.

7. **The Counting in digital acquisition**
   - Signals and encoders, tachymétriques signals;
   - Proximity sensors;
   - tachymétriques sensors;
   - Real time, internal clock.
8. Measures and units
9. Errors and Uncertainties
10. Measurement of refrigerated quantities
   • Pressure;
   • Temperature;
   • Refrigerated powers;
   • Air speed;
   • flow of air;
   • Water flow;
   • Quantity of heat.
11. Measuring electrical quantities
   • Voltage;
   • Intensity;
   • Resistance;
   • Impedance;
   • Capacity;
   • Inductance;
   • Electrical power.

❖ MMF 124: Fluid Mechanics

➢ Fluid Mechanics hydraulic unit: 2 credits (30 hours); L, T, PW
➢ Fluid Mechanics Aerodynamics: 2 credits (30 hours); L, T, PW

❖ MMF 115: Technology and Technique in Thermal Engineering

➢ Technology of thermal systems: 3 credits (45 hours); L, T, PW
   1. Burner and
      • Boilers Burners:
        - Characteristics;
        - Performance;
        - Design and maintenance problems.
      • The boilers:
        - General design;
        - different types;
        - Security Rules.
   2. Thermal engines and refrigeration machines
      • Component main and auxiliary.
   3. The ovens, main types following the use and the sources of energy
   4. Transfer and distribution of fluids
      • The Pumps: the different types, variable speed, Curves characteristics;
      • The fans: helical, axial, centrifugal, variable speed, the characteristic curves
   5. The aeraulic networks Hydraulic and
      • Components: tubes, sheaths, valves, bottles of decoupling, loss of load, balancing, …
1. Technique of Thermal Engineering: 2 credits (45 hours); L, T, P, PW
   - **T Training**
     - The Metals in sheet (tracing, crushing, drilling);
     - The pipes and ducts (characteristics, connection);
     - The Assemblies (welding, brazing, clips, bolts or screws, bolts, collages);
     - The materials of the Thermal Engineering (traditional metals, composite materials, plastics);
     - The machining by chip removal.
   - **P Training**
     - Work on the Metals in sheet (tracing, crushing, drilling);
     - The work of assembly (welding, brazing, drilling, tapping, collage);
     - The work of the disassembly and reassembly of the mechanical components of the specialty;
     - Electrical Work (wiring, method of diagnosis of simple failure);
     - Machining jobs of initiation tower milling machine.

2. MMF 125: Distribution of electrical energy and electricity
   - Distribution of the electrical energy: 2 credits (30 hours); L, T, P, PW
   - Electricity: 3 credits (45 hours); L, T, PW
     1. Notions of electrokinetics, currents, Single Phase and Three Phase
     2. Ohm’s law, generators of voltage and current in continuous current theorems of Thevenin and Norton
     3. Notions of dipole
        - Resistance;
        - Generator;
        - Active receiver.
     4. Single-phase alternating current
        - Definition;
        - Impedance;
        - Complex representation;
        - Types circuits;
        - Active and reactive power;
        - Rehabilitation of the power factor.
     5. 3 Phase Alternating Current
        - Production of a voltage three-phase alternative;
        - Star mounts and triangle;
        - Power.
     6. Losses, performance
     7. The Engines
        - Engines in alternating current;
        - Synchronous motors and asynchronous.
     8. Startup characteristics and operation, protection
     9. Speed control
     10. Choice by Report To use TS
11. **Standard (N.F.C 15.100 for example)**
12. **Strong currents**
13. **Symbolic of the wiring diagrams**
   - Codified representation of devices;
   - Markings on the devices.
14. **Structure of a typical installation in the tertiary sector**
   - Distribution;
   - Pipes;
   - Shields;
   - Lighting
   - Power outlet;
   - VMC;
   - Boiler room;
   - Cooling loop.
15. **Structure of a typical installation in the industrial sector**
   - Determination of the currents of C/C;
   - Protection of circuits and persons (Circuit breaker, relay, delesteurs...);
   - Groups of relief - low currents.
16. **Technical Alarms**
   - Object;
   - Analysis of a typical installation.
17. **Fire detection, intrusion alarm**
18. **Telephone and Computer circuits**
19. **Electrical measurements**
   - General principles and modalities.
20. **Current, voltage, power, impedance, use of the oscilloscope**
21. **Electronics**
   - Recovery;
   - Adjustment of power;
   - Amplifiers of difference;
   - Proportional system;
   - Integrator and splitter.
22. **The converters of electrical energy**
   - Chopper;
   - Ups;
   - Gradation of power;
   - Diode bridge.
23. **Transformer**
   - Transport of the electrical energy;
   - Safety systems in humid environment in particular.
24. **Production of electrical energy**
   - Alternator;
   - Photovoltaic cells.
25. **The storage of electrical energy**
   - Comparative study of the different batteries of accumulators.
**MMF 116: Thermodynamics**

- Thermodynamic : 5 credits (75 hours); L, T, PW
  1. Reminders and additions mathematics and general information on the thermodynamics
  2. Fundamental relations of thermodynamics
  3. The first principle of thermodynamics
  4. Second principle of thermodynamics
  5. Study of perfect gases
  6. Calorimetry
  7. Thermometry

**MMF 126: Thermal Transfer and Maintenance**

- Thermal Transfer I: 2.5 credits (37.5 hours); L, T, PW
  A. Conduction
    1. Physics bases
      - The conduction in a solid homogeneous and isotropic;
      - Hypothesis of Fourier;
      - Thermal conductivity;
      - Orders of Magnitude;
      - Influence of the temperature;
      - Approximation by a constant value.
    2. Contact with a solid with external sources solid or fluid
      - Physical concepts of boundary conditions, real contact, perfect contact;
      - Mapping by the coefficients for the exchange;
      - Evolution as a function of the change in the appearance of the surface by clogging, scaling, oxidation, ...
    3. Case of permanent phenomena
    4. Equation of heat (general form, simplified forms)
    5. Problem of wall
      - distribution of temperature;
      - heat flow density;
      - thermal resistance of a wall.
    6. Accoles walls, coefficient of transfer of a wall
      - Case of wall with internal production of heat;
      - thermal insulation of the flat surfaces.
    7. Cylindrical problems (cylinders full and tubes)
      - Distribution of Temperature;
      - Flow of heat per unit of length;
      - Thermal resistance of a cylinder, composite tubes;
      - Case of cylinder with internal production of heat;
      - Coefficient of transfer of a cylinder;
      - Thermal insulation of the lines;
      - Energy optimization;
• Critical radius;
• Succinct concepts on the spherical problems;
• Problems of cylindrical bars and fins;
• Efficiency and effectiveness;
• Use of these simple theoretical models for an approximate solution of real devices more complex (forms and boundary conditions simplified);
• Optimization Economic Of The walls The Insulating (Investment, operation);
• Case of Unsteady phenomena;
• equation of the heat;
• Concept of thermal diffusivity.

8. **Problem of the wall semi-infinite**
   • Case of a level of superficial temperature;
   • The case of a periodic variation of superficial temperature or flow;
   • Determination of the temperature field and stream;
   • Concept of thermal effusivity;
   • Abrupt contact between two walls isotherms.

9. **Cooling and warming of finite systems simple, walls, Cylinders, Spheres, parallelepipeds rectangles and short cylinders.**

10. Search for solutions with the help of either the analytical relations, either pre-existing charts, either computer means more or less developed (since the numerical methods to finite differences until the spreadsheets currents) by highlighting the strengths and drawbacks of the various methods.

### B. Convection

1. **Law of Newton**
2. **Coefficient of convective exchange. Order of Magnitude**
3. **Thermal resistance of convection**
4. **Description of the exchange of heat between a wall and a fluid**
   • The boundary layer dynamic;
   • Thermal boundary layer;
   • Laminar flows and turbulent;
   • Analogy of Reynolds;
   • Comprehensive Concept of similarity;
   • Characteristics numbers dimensionless.

5. **Studies of simple cases**
6. **Laminar flow force on a flat plate**
   • assumptions and results of the theory of Blasius ;
   • Laws of local transfer and global.
7. **Turbulent flow force on a flat plate**
   • appearance Conditions of turbulence;
   • transition.
8. **Experimental surveys of information and establishment of laws of correlation**
9. **Forces flows in tubes of Revolution**
• Notion of thermal lock due to the variability of the density as a function of temperature.

10. **Leak** The forces Around A Cylinder Of Revolution Place transversely.

11. **Natural convection** on flat plate or around the cylinders.
• Notion of stable configurations (stratification, a temperature inversion, environmental effects) and unstable.

12. **Thermosiphon**, circulation of chimneys

13. **Convection** with changes in States, boiling, condensation

14. **Laws of mass transfer**- analogy between heat and mass transfer

- **Organization of the maintenance II:** 2.5 credits (37.5 hours); L, T, P, PW

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**MMF 117: Written Expression (English) and legal environment**

- **Written Expression :** 1 credit (15 hours); L, T, PW

1. **Oral communication**
• Achievement of a presentation;
• Achievement of an interview;
• Response to an interview;
• Representation of a record; oral
• Summary of a text;
• Achievement of a role play or simulation;
• Initiation to the leadership and to the dynamics of the groups;
• Listening and Reading attentive of audio documents and or graphics.

2. **Achievement of a written message**
• Taking of notes;
• Administrative correspondence and professional (note, record, minutes, letter, CV, etc.);
• Private correspondence;
• Preparation of a survey;
• Design and realization of a slogan and an advertising message etc.;
• Drafting of instructions of use, security, standardization, etc.;
• Drafting of a leaflet;
• Drafting of a French composition;
• Methodology of the drafting of a report on the training, etc.

3. **Study of the communication situations**
• Identification of the factors in the situation of communication (issue, receiver, code, channel, message, context);
• Situation of communication and verbal interaction (utterance);
• Study of the elements para verbal cues (kinesthetic, proxémiques, MIMO-gestural;
• identification and handling of figures of expressions and thoughts (metaphors, irony, satire, parody, etc.).

4. **Typology of texts and documentary research**
• Reading of the texts of various nature (literature/non-literary, FIXED IMAGE/mobile, drawing of press, caricature, etc.);
• Analysis of advertising texts and speeches (scientific, political, literary, etc.);
• Constitution and operation of a documentation and mounting of folders;
• readings of texts cultivating the moral and civic values.

Legal environment: 2 credits (30 hours); L, T, PW
1. General introduction to the right
   • The concept of law;
   • The characters of the rule of law;
   • The sources of the law (the hierarchical standards);
   • The application of the Act (the non-retroactivity of the Act and the territoriality of the law);
   • The judicial institutions (courts, a principle of a double degree of jurisdiction, appeal in cassation);
   • Sanctions for violation of the rule of law (inhibition, execution, repair, repression).

2. Labor law
   • The sources of labor law;
   • The different labor contracts (conventional contracts and precarious contracts);
   • Execution of the work contract (payment of salary and claim of salary, different professional sanctions);
   • Dismissal and resignation;
   • Resolution of disputes in respect of work.

MMF127: Accounting and Economics

Accounting: 1 credit (15 hours); L, T, PW
A. General Ledger
1. The Company and its heritage
   • Concept of enterprise;
   • Balance sheet and its variations.
2. Analysis of the current operations of the company
   notion of jobs resources;
   The accounting transfer;
   Of account to the balance
3. The operations of purchases and sales
   • Billing;
   • accounting registration;
   • system of inventory;
   • plug of stock.
4. The regulations on term: the effects of trade
   • defintion
   • principles:
• calculations
5. **The depreciation and amortisation**
   • definition;
   • accounting registration;
   • typology.

**B. General introduction to the Financial Analysis**

1. **Analysis of the balance sheet**
   • Presentation Summary of the balance sheet.
2. **Study of the structure of the balance sheet**
   • calculations of ratios.
3. **Functional analysis of the balance sheet**
   • Definition;
   • Principles;
   • Computations;
   • Table of exploitation functional.
4. **Differential analysis of the balance sheet**
   • Definition;
   • Principles;
   • Computations;
   • Table of exploitation differential.

**C. Analytical accounting of management**

1. **Generality on the cage**
   • Objective;
   • Role;
   • Concept of Load.
2. **Analysis of expenses**
   • Liable loads;
   • Direct expenses, indirect;
   • valuation of stocks.
3. **Method of full costs**
   • Cost of purchase;
   • Cost of Production;
   • cost of returns;
   • Calculation of the result.

➢ **Economy: 2 credits (30 hours); L, T, PW**

1. **Notions of general economy**
   • Introduction;
   • The consumption and production;
   • The training of income;
   • The currency and credit;
   • The prices;
   • The concept of growth and development.
2. **The Company**
   • Introduction;
   • Typology of enterprises;
• Structure and organization of the enterprise;
• The Company and the ethics;
• How to undertake (Create, decide, manage).

3. The place of the company in the economic fabric
• Concept of the environment of the company;
• The relations inter- and extra-enterprises;
• the commercial activity;
• notion of strategy.

4. The productive activity
• The policies and processes of production;
• trade policies;
• Logistics.

5. The concept of management in the company
• The activity and financial resources;
• The planning and management of human resources;
• The planning and management of hardware resources.

6. Information and communication in the company
• Role of Information and communication;
• Collection and organization of information;
• Strategic Diagnostic
• decision system

❖ MMF 231: Mathematics III

➤ Mathematics III: 4 credits (60 hours); L, T, PW

Numerical Methods and Data Analysis
1. Introduction
• Magnitude of measurement, measured value and unit;
• Definition of different types of errors;
• measurement uncertainties.

2. Statistical methods
• Mean values and standard deviation;
• Binomial distribution and distribution of fish;
• Methods of calculations of errors: approximations and separation of values
  - Approximation by the method "Least Square" (least square fits);
  - Separation of values;
  - Approximation to from a polynomial;
  - Approximation of Lagrange.

3. Fourier methods
• Fourier transform and TFF;
• auto correlation;
• cross-correlation.
MMF 241 Mathematics IV

- Mathematics IV: 4 credits (60 hours); L, T, PW
  1. Introduction
     • Purpose and objective of numerical methods.
  2. Polynomial integration
  3. Digital integration
  4. Root of a function
     • dichotomy;
     • Newton-Raphson;
     • Secant.
  5. Digital methods of algebra
     • Gauss-Jordan;
     • Cholesky;
     • Decomposition;
     • Jacobi;
     • Gauss-Seidel;
     • Fadeev-Leverrier.

MMF 232 : Physics and Chemistry II

- Physics III: 3 credits (45 hours); L, T, P, PW
  1. Thermodynamics
     • Temperature and thermal expansion;
     • Heat and fundamental principle of thermodynamics;
     • Change of state of a gas ideals;
     • Kinetic theory of the heat;
     • Cyclic process: 2th fundamental principle of thermodynamics;
     • change of state;
     • Spread of the heat.
  2. Electrodynamics and applications:
     • Currents and fields;
     • Production of magnetic fields;
     • The induction phenomenon;
     • Alternating current;
     • electromagnetic waves.

- QSHE Base: 2 credits (30 hours); L, T, P, PW
  A. Quality
     1. Quality and governance of information systems
        • Security of Information and ISO 27001;
        • Identity and Access Management;
        • Business continuity plans, contingency plans it.
  B. Hygiene
  C. Safety
     1. Electrical safety
• Risks associated with the electrical current;
• instructions to apply and reflexes to have;
• care to injured persons after electrical shock.

2. **Ergonomics of the work station**
   • The risks related to the work on screen, myths and realities;
   • The reduction of risks by the development of the position of the work and tasks.

3. **Health and Safety at Work**
   • The issues, human, social, economic and legal;
   • The mechanisms at the origin of an accident at work; notions of basis for the health and safety at work; evaluation and control of risks in business.

D. **Environment**
1. **Eco-ICT, alias "Green IT"**
   • Position of the problem;
   • Possible actions at the level of the datacenter;
   • Possible actions at the level of the machines;
   • possible actions at the level of the network;
   • Among the particular.

3. **Protection of the private life**
   • definitions;
   • Basic principles;
   • Technologies for the protection of the private life.

4. **Electromagnetic Risk**
   • Basic concepts;
   • Electromagnetic environment;
   • Electromagnetic compatibility;
   • Exposure of individuals to electromagnetic fields.

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**MMF 242: Computer Science II**

- **Computer Science II: 5 credits (75 hours); L, T, P, PW**

1. **Border" machine (Hardware) - Man (Software)" as solutions to problems**
   • The bios;
   • The systems of applications;
   • application programs.

2. **Operating the machine and examples of operating system;**
   • WINDOWS (DOS);
   • Linux: an interesting alternative.

3. **A few examples of application software:**
   • The "Package Microsoft Office";
   • The software of navigation and search engines on the Web.
MMF 233: Thermal transfers II and organic chemistry

- Thermal transfers II: 3 credits (45 hours); L, T, P, PW

1. Thermal radiation
   - Physical Laws of thermal radiation:
     - Emission;
     - Transmission;
     - Reception.
   - Definitions of radiative quantities relating to the issuance
     - Stream;
     - Intensity;
     - Luminance;
     - emit importance;
     - Lighting.
   - The issue of the black body:
     - Laws of Stefan-Boltzmann, Planck, Wien.
   - Emission of real bodies compared to that of a black body:
     - Emissivity
     - Indicative of emission.
   - Other radiative properties of the body:
     - Reflection;
     - Absorption;
     - Transmission;
     - Definition of the factors of reflectivity, of absorbency, monochromatic transitivités total and;
     - Act of draper.

2. Coupled transfers
   - Of mixed problems will be dealt with or coexist the different modes of heat transfer. In particular, special attention will be accorded on the fact that, in a set technique, the different components interfere from the thermal point of view and that a practical problem is essential to ensure, even at the project level, that at no point of temperature limits are likely to be affected, whatever the conditions of operation (in particular, it is often wise to check the evolution of the temperature field in any point of the whole studied during the shuTown of the pumps or fans);
   - Comparisons will be conducted between the results obtained on the fields of temperature and on the energy performance of a set technical, for a total of nine in the nominal conditions of operation and for the same set in "Defect operation", that is to say after clogging of exchange surfaces, change of émissivités by oxidation, reduction of sections of pipes by scaling.

- Organic Chemistry: 2 credits (30 hours); L, T, P, PW
MMF 243: materials and conversion of energy

- Conversion of energy: 1.5 credits (22.5 hours); L, T, PW
- Organic materials: 1.5 credits (22.5 hours); L, T, PW

MMF 234: technical studies and Personal Project

- Personal and Professional project: 3 credits (45 hours); L, T, PW
  1. Define a problematic
     - How to analyze and install a problem from a complex situation.
  2. Control the time
     - Know decompose a project in phase and basic tasks;
     - Estimate the time and deadlines;
     - Build a calendar.
  3. Work in a group
     - Control the various compartments of the work in the group.
  4. Negotiate
     - Know-how, but also to obtain a consensus with partners (clients or members of the Group project).
  5. Evaluate
     - What indicators, what evaluation criteria guarantee the quality of the project.
  6. Control the oral and written presentation

Technical studies: 2 credits (30 hours); L, T, PW

MMF 244: Maintenance II

- Technique of maintenance, conduct, prevention II: 2 credits (30 hours); L, T, P, PW
- Studies of the installations: 2 credits (30 hours); L, T, P, PW

MMF 235: fluids and Networks

- Fluids and Networks: 2 credits (30 hours); L, T, P, PW
  1. Typology of networks
     - Specific vocabulary to networks;
     - Simple networks, branched mesh.;
     - Transport Networks (oil, water, steam, air, gas);
     - Condition of inflexibility of the flow of a gas in a network.
  2. Sizing of a simple network
     - Dimensional analysis of losses of loads;
     - Algorithm for sizing for a simple network;
     - The sizing criteria (energy, acoustic, financial).
3. Complex Networks
   • Determination of the characteristic of a network series or parallel;
   • Characteristic of a branched network, coupling network / machines (operating point), balancing of a network.

4. Summary description common pathologies
   Waterhammer;
   • Refoulement;
   • Cavitation;
   • Instability of pumping.

5. Aeraulics sizing
   • Study the components of a network of ventilation (various types of fan, woofer, the mouths of blowing or resumed, registers, ...);
   • Practical bases for sizing and balancing of a network of ventilation and implementation; and
   • Evaluation of the consumption of energy and the maintenance necessary.

- Fluids : 2 credits (30 hours); L, T, PW

- MMF 245: realization, implementation of procedures II and business software, Energy and Environment

- Achievement, implementation procedures : 2 credits (30 hours); L, P, PW

- Trades software: 1.5 credits (22.5 hours); L, T, PW

- Energy and Environment: 1.5 credits (22.5 hours); L, T, PW

1. Environment and Energy issues - climate
   • Concept of the environment;
   • Impact of thermal engineering on the environment.

2. The physical aspects of climate change
   • Mechanism of the greenhouse effect;
   • Radiative balance of the Earth;
   • The time constants in the Climate Change: geology, astronomy, role of the oceans, the role of the atmosphere, human activities.

3. Of the Warming Climate, At the Change Climate
   Then Global change
   • The IPCC;
   • The climate models;
   • The scenarios of emissions.

4. Greenhouse Gases
   • The different greenhouse gases and their origins (natural and anthropogenic);
• The correlation \{CO2 - Temperature\} in the paleo climates;
• The Power Of Global Warming a greenhouse gas;
• The concepts of CO2 equivalent, carbon equivalent;
• The accounting "carbon" and the method Carbon balance;
• The carbon count;
• The methodology of the carbon balance, the choice of the perimeter, the extractions.

5. Work around of case studies on the Software (anglo-saxon or European)

6. The energy issues

7. The panorama global energy
   • The primary resource (natural) and the final energy (commercial);
   • The relative shares of fossil energies, Biomass hydraulic, nuclear and renewable in this balance sheet;
   • The international recognition of the electricity;
   • The energy vectors: heat and electricity.

8. Energy efficiency: the final energy to the useful energy
   • The production of ECS: natural gas or electricity (nuclear, hydraulic, thermal) or solar thermal heating;
   • The Transportation: liquid fuel oil tanker, hydrogen fuel cell, electric.

9. Mechanical energy: Tools electric or pneumatic compressed air

10. Pollution

11. The sources of pollution (physical, chemical and thermal),
   • The necessary actions;
   • The international decisions;
   • Reduction of pollution (choice of the form of energy, evolution of equipment and professional rules);
   • The pollution of the waters of thermal discharge;
   • The sources of water pollution: thermal, chemical.

❖ MMF 236: Realization, implementation of procedures I and Regulation

➢ Regulation: 2 credits (30 hours); L, T, P, PW

1. Introduction to the regulation and the automatic
   • Purpose;
   • Definitions;
   • Basic Principles.

2. Mathematical description and linear dynamic systems types (1 and 2Nd order)
   • Modeling and equation;
   • Laplace transformation;
   • Transfer function;
   • Temporal analysis;
   • Performance of Systems (response time, stability, precision, overflow, etc.).
3. **Regulation of industrial systems (Basics)**
   - Operational objectives;
   - Modes of regulation;
   - Technology of the regulators;
   - Regulation procedure and application to a few examples in the industry and in cold.

4. **Regulation of refrigerated facilities**
   - Objectives and specificities of the Regulation of refrigeration circuits;
   - Study of a few techniques of regulation: temperature, pressure, the refrigerant level, oil, vacuum, de-icing;
   - Study of flow regulators of power in fluid (different regulators).

5. **Regulation of systems in air conditioning**
   - Study of a few regulating systems used in air conditioning (central processing of air, systems to direct relaxation, group of production of ice water, fan-coil units, pumps in icy water, systems VRV, etc.).

6. **Introduction to the technical management of the building and to the rational use of energy in air conditioning in the building**
   - Achievement, implementation of the procedures I: 2 credits (30 hours); L, T, P, PW
     1. Certification of a sanitary installation
     2. Maintenance of sanitary installations
     3. Sealing

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**MMF 246: Professional internship**

- Professional Internship: 6 credits (90 hours); P, PW
  1. Arrival and Business Integration
  2. Working in a company
  3. Holding of the Intern journal
  4. Choice of the theme of work in collaboration with the professional picture framer and the academic framer
  5. Elaboration of the canvas of research
  6. Resources to exploit
  7. Organization of work
  8. Drafting of the report
  9. Presentation of the report before a jury

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**MMF 237: French and Methodology of drafting of internship report**

- French: 2 credits (30 hours)
  1. Vocabulaire
     - Vocabulaire technique usuel
  2. Grammaire
- Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé ; imparfait, futur, conditionnel, et plus-que-parfait, l’impératif, l’infinitif, voix passive ;
- De l’adjectif : Qualificatif, possessifs, démonstratifs, interrogatifs, numéraux, indéfinis ;
- Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable, et non-dénombrable ;
- Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
- De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
- Des fonctions grammaticales.

3. Expression et communication
- Compréhension et interaction au cours d’une discussion technique ;
- Communication orale courante ;
- Communication orale interactive
- De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative ;
- Lecture rapide et compréhension de texte ;
- synthèse d’un long texte
- De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance – d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
- Gestion d’une table ronde/discussion : La prise de notes, la prise de parole
- Expressions figées

➢ Methodology of drafting of the IR: 1 credit (15 hours); L, T, PW

A. Drafting and structuring of the probation report
1. General Approach
   • Nature and contents of the report of internship;
   • Paragraph ;
   • The style and spelling.
2. Structuring of the document
   • Coverage;
   • Acknowledgments;
   • In-head of the probation report;
   • Executive Summary;
   • List of Figures and list of tables;
   • Glossary;
   • Body of the report of internship;
   • Bibliography;
   • Annexs;
   • Summarizes and keywords.

B. Formatting of the probation report
1. General information
   • Remission of the probationary report;
   • choice of software.
2. **Rules of presentation**
   - Size of the probation report;
   - Page layout;
   - Families of fonts;
   - Sizes and styles of fonts;
   - spacings
   - pagination.

3. **Notes at the bottom of the page**

4. **Floaters**
   - Tables;
   - Figures;
   - List of Figures List of tables;
   - equations;
   - Glossary.

5. **Bibliography**
   - Purpose of the bibliographic citations;
   - Format of bibliographic citations;
   - pop-up
   - List of bibliographic references;
   - Bibliographic references for the electronic documents.

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**MMF 247: Business creation and Civic and moral education**

- **Business creation: 1 credit (15 hours); L, T, PW**
  1. Concept of contractor
  2. Motivations to the creation of a business
  3. Search for ideas and Evaluation
  4. Research Funding
  5. Choice of legal status
  6. Ethical aspects of business

- **Civic Education and Ethics: 2 credits (45 hours); L, T, PW**
  
  **The Concepts**
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
• The freedoms;
• The public service;
• Ethics;
• Ethics, Law and reason;
• Ethical Problem;
• Ethics and management.
• Civics
• Deontology
• Moral consciousness
• The universal declaration of Human Rights
• Good governance in public services
• The importance of civics to the life of the nation
• Functions of the state and its citizens
• Deontology, Professional ethics and professionalism
• Relationship between morality, law and ethics
• Codes of ethics

The Minister of Higher Education

Pr. Jacques FAME NDONGO
Field: PETROLEUM AND MINING ENGINEERING

Specialty: APPLIED GEOLOGY
1. The objective of the training

This Specialty leads to the training of specialists in geology able to organise, administer and control a field of research or studies. They intervene upstream of the extractive industries of ores, minerals, water resources.

2. Research Skills

   → Generic Skills

   - Work independently, collaborate as a team;
   - Analysis and synthesis of professional documents (French, English);
   - Oral, written and corporate communication skills within and without (French, English);
   - Participate /engage in the management of the project;
   - Know and make use of professional networks and institutions of geology sectors.

   → Specific skills

   - Contribute to the development of the technical field of a study;
   - Participate in the administrative approaches, social and legal affairs;
   - Participate in the development of the quotation of an operation from the technical file;
   - Contribute to the material preparation of sites;
   - collect sample required for studies
   - to prepare the installation of site
   - Produced a report in accordance with the specifications; and economical estimation of the field or prospect ensure the good and the good economy of the Yard.

3. Career opportunities

   - The sectors that use or put in the value of the soil and the subsoil (mines and quarries, search for oil);
   - In geotechnical engineering (geotechnical studies and recognition of sites prior to the construction of works or the opening of the field);
   - In hydrogeology (their interventions will help to manage and operate a underground water or a course of water).
4. Organization of the Teachings

- **FIRST SEMESTER**

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<td>APG113</td>
<td>General geology Basic Data and Morphogenesis – historical geology I</td>
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<td>Materials of the earth crust -P Petrography I</td>
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5. Courses content

❖ **APG 111: Mathematics I**

- **Mathematics I**: 5 credits (75 hours); L, T, SPW
  1. Resolution of the Geometric Problems
  2. Study of the usual functions
  3. Resolution of differential equations

❖ **APG 112: Physics I**

- **Physics I**: 4 credits (60 hours); L, T, P, SPW
  - **Electrical concepts**
    1. **Electrostatic**
       - electric field;
       - potential;
       - flow.
    2. **Electrokinetics**
       - Electrical resistivity;
       - Concepts on the linear networks.
    3. **Electromagnetics**
       - Notions of magnetic field;
       - The sources of magnetism.

❖ **APG 113: General geology: Basic Data and morphogenesis-Historical geology I**

- **General geology: Basic Data and morphogenesis**: 4 credits (60 hours); L, T, SPW
  1. **Basic Data**
     - Methods and disciplines of the geology;
     - Constitution of the terrestrial globe;
     - Notion of global tectonics.
  2. **Morphogenesis**
     - The agents and process of evolution the morphogenetic;
     - Influence of the nature of the rocks on the modeled;
     - Influence of the structure on the modeled;
     - Geomorphological comment.
  3. **Historical geology I**
     - Geological timeline;
     - Stratigraphy;
     - The main traits of paleogeographic evolution of Cameroon, Paleozoic to Quaternary.
APG 114: Materials of the earth crust - P Petrography I

- Materials of the earth crust - P Petrography I : 5 credits (75 hours); L, P, SPW
  
  1. **Mineralogy**
     - Geometric crystallography;
     - The mineral and its properties;
     - The silicate minerals and non-silicates.
  
  2. **Endogenous Petrography**
     - The metamorphism and metamorphic rocks;
     - Magmatism and igneous rocks.
  
  3. **Exogenous Petrography**
     - The sedimentary phenomenon and the different groups of sedimentary rocks

APG 115: Structure of the sub-soil: Tectonics - Geological Mapping

- Structure of the sub-soil: Tectonics - Geological Mapping: 4 credits (60 hours); L, T, SPW
  
  1. **Tectonics**
     - Stresses and deformations, ellipsoid associated;
     - Reminder of global tectonics, tectogenese, orogenesis;
     - Elements of microtectonique;
     - Relations with local and regional tectonic.
  
  2. **Mapping**
     - Interpretation reading exercises on topographic maps, and geological maps.

APG 116: Topography and technology of survey

- Topography: 3 credits (45 hours); L, P
  
  1. Presentation and handling of instruments used for the measures of the Angles, distances and elevations
  2. Surveys and report of Surveys (manual and automatic)
  3. Initiation to the D.A.O

- Technology of survey: 2 credits (30 hours); L, T, P
  
  1. The boring machines: conventional machines and special survey
  2. The tubular material and the Normalization API
  3. The types of the tools
APG 117: Bilingual training

- **English : 1.5 credits (22 hours 30mn)); L, T, SPW**
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication.
  4. **Autonomous reading of “writings” of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
     - C.V;
     - Letter of motivation;
     - Letter/memo writing and minutes of a meeting

- **French : 1.5 credits (22 hours 30mn)); L, T, SPW**
  1. **Vocabulaire**
     - Vocabulaire du matériel de **technologie agro-alimentaire**
     - Vocabulaire des **produits agro-alimentaires**
     - Vocabulaire des **activités agro-alimentaires**
     - Vocabulaire des **actants**
     - Vocabulaire des **affaires**
  2. **Grammaire**
     - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
     - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
     - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
     - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
     - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
     - Des fonctions grammaticales.
  3. **Expression et communication**
     - Compréhension et interaction au cours d’une discussion technique ;
Communication orale courante ;
Communication orale interactive ;
De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
Lecture rapide et compréhension de texte ;
Synthèse de texte
De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
Expressions figées

APG 121: Chemistry I

Chemistry I: 5 credits (75 hours); L, T, P, SPW

1. General Chemistry
   - Thermodynamic ;
   - Aqueous solutions;
   - Chemical kinetics.

APG122 : Computer for Business I and Computer programming

Objectives: at the end of this courses students should achieve knowledge and practical know-how related to computer concepts and programming

Computer for Business I: 2 credits (30 hours); L, T, P, SPW

1. Generalities, impact of computer on society, current notions, basic hardware, software and networking
2. Procedures in using computer systems
3. Practical approach - hands- on
4. MS word; -MS excel; -MS power point; -Ms access

Computer programming: 2 credits (30 hours); L, T, P, SPW

Generalities on Programming ,Delphi and Visual Basic Programming: Visual Basic concepts, Designing programs, Program Flow, Testing and Debugging, Functions, Arrays, Interacting with the user, Interacting with the system; Mastering of professional Software; Algorithms
APG 123: Historical Geology II unto Paleontology unto microfacies

- Historical Geology II - paleontology - microfacies: 5 credits (75 hours); L, T, SPW
  1. General information
     - The fossilization;
     - Harvesting and preparation of samples;
     - Stratigraphic fossils and fossils of facies.
  2. Systematic
     - Study of the main lines of the animal kingdom and the plant kingdom.

APG 124: Techniques for studies of minerals and rocks

- Techniques for studies of minerals and rocks: 5 credits (75 hours); L, P, SPW
  1. Statement of Principles and the methodology and then implementation of the conventional techniques of studies of minerals and rocks such as:
     - Principles of the panning;
     - Particle size analysis;
     - Separation of minerals;
     - physical and chemical tests
     - Morphoscopie.

APG 125: Remote sensing and GIS

- Remote sensing and GIS: 3 credits (45 hours); L, P, SPW
  1. Satellite imagery and Geographic Information System;
  2. The different typesof images;
  3. The refund of the relief from the images;
  4. The influences of the lithology and structure on the morphology and vegetation. Application to the geological mapping and to some of the problems of applied geology.

APG 126: Field camp and drawing of construction

- Field Camp I: 2 credits (30 hours); P
  1. Lifted to flush fitting
  2. Petrography study, paleontological eventually and if possible sedimentological
  3. Report of the information of the Field tripin Notebook
  4. Elaboration of a report of activity to the return
  5. Geological Mapping: - Survey of geological cross section
  6. identification of the outcrops on a topographic map
Drawing of construction - Workshop: 3 credits (45 hours); L, P

1. Drawing of construction
   - The Standardized conventions of representation;
   - Reading of a technical drawing;
   - Execution of the design of a mechanical part (Technology Tools for drilling), in the form of freehand sketches and in the form of release to the net.

2. Workshop
   - Initiation to the use of tools, machines and instruments to measure classics (ohm-meter, voltmeter,...);
   - Security measures in the mining field.

APG 127: Computer for business II / Civic and moral education

Computer for Business II: 1 credits (15hours); L, T, P, SPW

1. Revision on: -MS word -MS excel -MS power point -Ms access
2. office automation
3. graphics and graphing packages
4. internet working
5. information services

Civic and Moral Education: 2 credits (30 hours); L, T

The Concepts
- The citizen;
- The Nation;
- The State;
- Publics Property and collective’s goods;
- The freedoms;
- The public service;
- Ethics;
- Ethics, Law and reason;
- Ethical Problem ;
- Ethics and management.
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics
APG 231: Mathematics II

- Mathematics II: 5 credits (75 hours); L, T, SPW
  1. Initiation to a few notions of spectral analysis
  2. Initiation to the calculation of probabilities followed by notions of inferential statistics leading to the construction of the statistical tests the most simple

APG 232: Physics II

- Physics II: 4 credits (60 hours); L, T, P, SPW
  1. Electric machines
  2. The measures electrical and electronic equipment
  3. The concepts of optics
  4. Notions of mechanical systems

APG 233: Sedimentology and geology of the basins - Petrography II

- Sedimentology and geology of the basins - Petrography II: 4 credits (60 hours); L, P, SPW
  1. Sedimentology and geology of the basins
     - The stratification
  2. The rhythmicity:
     - Concept of sequence;
     - Sampling techniques.
  3. Genetic interpretation
     - Principle;
     - Examples.
  4. The minerals of the rocks, of the gites and gangue materials
     - Macroscopic observations on isolated samples and presentation of few thin section.

APG: 234: Investigation Methods: Geological - Geophysical – and geochemical

- Investigation Methods: Geological - Geophysical – and geochemical: 5 credits (75 hours); L, T, P, SPW
  1. Geological Methods - Geophysicals
  2. Use of measuring instruments elementary and practice of the usual techniques of data acquisition
  3. Exploitation of the results of physical measures
  4. Guided study of concrete cases implementing of electric recordings and Seismic
APG: 235: Structure of the sub-soil: Tectonics - Structural Analysis

- Structure of the sub-soil: Tectonics - Structural Analysis: 4 credits (60 hours); L, P, SPW
  1. The tools
     - Presentation;
     - Principles;
     - Realization of diagram.
  2. Application to the study of continuous deformations and staple fibers
  3. Relations between the phenomena at different scales
  4. The Structural cards (understanding and development of documents)

APG 236: Field trip II

- Field trip II: 5 credits (75 hours); P, SPW

Geological study in depth in a specified territory. The student should have a fairly good idea of the geology of Cameroon. Various aspects of the geology, geotechnical (stability of land, materials exploitable,...) and of the hydrogeology (water resources, pollution,...) will also be addressed in function of local opportunities.

APG 237: Accounting and labor law

- Accounting: 2 credits (30 hours); L, T, SPW
  1. Generality on analytical accounting and business management
     - Objective;
     - Role;
     - Concept of burden.
  2. Analysis of expenses
     - Liable burdens;
     - Direct and indirect expenses;
     - Valorisation of stocks.
  3. Method of full costs
     - Cost of purchase;
     - Cost of production;
     - Cost of returns;
     - Calculation of the results.

- Labor law: 1 credit (15 hours); L, T, SPW
  A- First Part
  1. The concept of law
  2. The characters of the rule of law
  3. The sources of law (the hierarchical standards)
4. The application of the Act (the non-retroactivity of the Act and the territoriality of the law)
5. The judicial institutions (courts, a principle of a double degree of jurisdiction, appeal in cassation)
6. Sanctions for violation of the rule of law (inhibition, execution, repair, repression)

B- Second Part
1. The sources of labor law
2. The different labor contracts (conventional contracts and precarious contracts)
3. Execution of the work contract (payment of salary and claim of salary, different professional sanctions)
4. Dismissal and resignation
5. Resolution of disputes in respect of work

❖ APG 241: Industrial Safety and safety culture

➢ Industrial Safety and safety culture: 4 credits (60 hours), L, T, SPW

General objective:
Understand the importance of safety in industry, Know the causes and ways of preventing industrial accidents not caused by Fire, Appreciate what is involved in safety inspection, Appreciate the various causes and fire prevention in industry. Know the various methods and proceedings in firefighting. Appreciate the factories act and the principals involved in factory law.

Contents:
importance of safety in industry, causes and ways of preventing industrial accidents not caused by Fire, involvement of safety inspection, causes and fire prevention in industry, methods and proceedings in firefighting, factories act and the principals involved in factory law.

❖ APG 242: Chemistry II: 5 credits (75 hours); L, T, P, SPW

➢ Chemistry II: 5 credits (75 hours); L, T, P, SPW

1. Mineral chemistry
   - Chemical properties essential of the different families of the Periodic classification

❖ APG 243: Geotechnical Engineering: Soil Mechanics

➢ Geotechnical Engineering: Soil Mechanics: 4 credits (60 hours); L, P

1. Mechanics of theoretical soils
2. Properties of soils and rocks
3. Calculation of books
4. Conduct of the project of recognition
5. Applied Geology on sites

❖ APG 244: Hydrology: 4 credits (60 hours); L, T, P, SPW

➤ Hydrology: 4 credits (60 hours); L, T, P, SPW

1. Hydrology
   - The water cycle;
   - Atmospheric waters and precipitation;
   - Evaporation and evapotranspiration;
   - The waters of surfaces;
   - Groundwater;
   - The water and its movements in the soil;
   - aquifers.

2. Hydrogeology

3. Hydrochemistry

4. Operation of the water

❖ APG 245: Metallogeny Mineral deposit estimation

➤ Metallogeny Mineral deposit estimation: 4 credits (60 hours); L, P, SPW

1. Metallogeny
   - Introduction;
   - Classification of mineral deposits;
   - The different types of deposits.

2. Mineral deposit estimation
   - The different types of exploitation and specific methodologies.
   - Case of aggregates:
     - Basic data;
     - Exploitation of aggregates;
     - Treatment of aggregates;
     - Specification;
     - Use of aggregates;
     - Products.

3. Organization and conduct of construction site
   - Administrative and Legal Issues;
   - The financial problems;
   - human problems.

❖ APG 246: Professional internship

➤ Professional internship: 6 credits (90 hours); P

1. Arrival and integration in the enterprise
2. Working in an enterprise
3. Holding of the Internship journal
4. Choice of the topic of work in collaboration with the professional trainer and the academic supervisor
5. Elaboration of the research outline
6. Resources to exploit
7. Organization of work
8. Drafting of the report
9. Presentation of the report before a jury

APG 247: Economics

- Economics: 3 credits (45 hours); L, T, SPW 1. Economic

1. Basic Concept of Economics
   - Definition Adam smith, Alfred Marshall, Prof, Robins
   - Natural and Scope.
   - Importance for technicians.
2. Basic Concept of Economics
   - Utility.
   - Income.
   - Wealth.
   - Saving.
   - Investment.
   - Value.
3. Demand and Supply
   - Definition.
   - Law of Demand.
   - Definition of Supply.
   - Law of Supply.
4. Factors of Production
   - Land.
   - Labor.
   - Capital.
   - Organization.
5. Business Organization
   - Sole Proprietorship.
   - Partnership.
   - Joint Stock company
6. Entrepreneurial Skills
   - Preparing, planning, establishing, managing, operating, and evaluating relevant resources in small business.
   - Business opportunities, goal setting.
   - Organizing, evaluating, and analyzing opportunity and risk tasks.
7. **Scale of Production**
   - Meaning and its determination.
   - Large scale production.
   - Small scale production.

8. **Economic Systems**
   - Free economic system.
   - Centrally planned economy.
   - Mixed economic system.

9. **Money**
   - Barter system and its inconveniences.
   - Definition of money and its functions.

10. **Bank**
    - Definition.
    - Functions of a commercial bank.
    - Central bank and its functions.

11. **Cheque**
    - Definition.
    - Characteristics and kinds of cheques.
    - Dishonor of cheque.

12. **Financial Institutions**
    - IMF.
    - IDBP.
    - PIDC.

13. **Trade Union**
    - Introduction and brief history.
    - Objectives, merits, and demerits.
    - Problems of industrial labour.

14. **International Trade**
    - Introduction.
    - Advantages and disadvantages.

15. **Management**
    - Meaning.
    - Functions of management.

16. **Advertisement**
    - The concept, benefits, and drawbacks.
    - Principal media used in business world.

17. **Economy of Cameroon**
    - Introduction.
    - Economic problems and remedies
Field: PETROLEUM AND MINING ENGINEERING

Specialty:

DRILLING TECHNOLOGY
1. The objective of the training

The objectives of this course are to Produce skilled manpower for the deployment at any surface mining project and Develop the knowledge and operating skills of the trainees about various mining equipment’s and technology.

2. Research Skills

At the end of the course, the trainee must be able to attain the following competencies about surface mining operations:

→ **Generic Skills**
  - Work independently, collaborate as a team;
  - Analysis and synthesis of professional documents (French, English);
  - Oral, written and corporate communication skills within and without (French, English);
  - Participate /engage in the management of the project;
  - Know and make use of professional networks and institutions of drilling sectors.

→ **Specific skills**
  - Identify the different types of surface mining methods
  - Identify the different industrial minerals and rocks
  - Identify the name and functions of various drilling equipment’s and their uses.
  - Operate and maintain Top-hammer drills including start-up/Shut-down, positioning, vertical drilling, angle-drilling, drill rod changing, and drill rod retrieval
  - Operate and maintain Down-the-Hole drills including start-up/shut-down, positioning, drilling, drill rod changing, and drill rod retrieval
  - Operate and maintain Jack-hammer/Hand-held drills including start-up/shut-down, rock drilling, rod retrieval
  - Operations and handling of Air Compressors, including start-up/shut-down, oiling/greasing, filter changing, pressure maintenance
  - Drilling and Core logging for mineral explorations and resource evaluation
  - Usage and preparation of High explosives and blasting agent
3. Career opportunities

- Cement factories (limestone or shale quarries)
- Marble and Granite quarries
- Construction companies
- Mineral exploration and production companies
- Geotechnical services companies
- Gold project
4. Organization of teachings

- **FIRST SEMESTER**

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- **SECOND SEMESTER**

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### THIRD SEMESTER

**Field: Petroleum and Mining Engineering**

**Specialty: Drilling Technology**

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### FOURTH SEMESTER

**Field: Petroleum and Mining Engineering**

**Specialty: Drilling Technology**

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5. Courses content

❖ DRT 111: Mathematics I

➢ Mathematics I: 4 credits (60 hours); L, T, SPW

1. Quadratic Equations
2. Arithmetic Progression and Series
3. Geometric Progression and Series
4. Binomial Theorem
5. Partial Fraction
6. Fundamentals of Trigonometry
7. Trigonometric Functions and Ratios
8. General Identities
9. Solution of Triangles
10. Mensuration of Solids
11. Vectors
12. Matrices and Determinants

❖ DRT 112: Physics

➢ Physics: 5 credits (75 hours); L, T, P, SPW

1. Measurements
   - Fundamental units and derived units.
   - Systems of measurement and S.I Units.
   - Concept of dimensions, dimensional formula.
   - Conversion from one system to another.
   - Significant Figures.
2. Scalars and Vectors
   - Revision of head to tail rule.
   - Laws of parallelogram, triangle, and polygon of forces.
   - Resolution of a vector.
   - Addition of vectors by rectangular components.
   - Multiplication of two vectors, dot product and cross product.
3. Motion.
   - Review of laws and equations of motion.
   - Law of conservation of momentum.
   - Angular motion.
   - Relation between linear and angular motion.
   - Centripetal acceleration and force.
   - Equations of angular motion.
4. Torque, Equilibrium, and Rotational Inertia
   - Torque.
   - Center of gravity and center of mass.
   - Equilibrium and its conditions.
- Torque and angular acceleration.
- Rotational inertia.

5. **Wave Motion.**
- Review Hook's law of elasticity.
- Motion under an elastic restoring force.
- Characteristics of simple harmonic motion.
- S.H.M and circular motion.
- Simple pendulum.
- Wave form of S.H.M.
- Resonance.
- Transverse vibration of a stretched string.

6. **Sound**
- Longitudinal Waves.
- Intensity, loudness, pitch, and quality of sound.
- Units of intensity of level and frequency response of ear.
- Interference of sound waves, silence zones, beats.
- Acoustics.
- Doppler Effect.

7. **Light**
- Review law of reflection and refraction
- Image formation by mirrors and lenses.
- Optical instruments.
- Wave theory of light.
- Interface, diffraction, polarization of light waves.
- Applications of polarization in sun glasses, optical activity and stress analysis.

8. **Optical Fiber**
- Optical communication and problems.
- Review total internal reflection and critical angle.
- Structure of optical fiber.
- Fiber material and manufacture.
- Optical fiber – Uses.

9. **Lasers**
- Corpuscular theory of light.
- Emission and absorption of light.
- Stimulated absorption and absorption of light.
- Laser principle.
- Structure and working of lasers.
- Types of lasers with brief description.
- Applications, basic concepts.
- Material processing.
- Laser welding.
- Laser assisted machining.
- Micro matching.
- Drilling, scribing and making.
10. **Heat**
- Review of calorimeter and gas laws.
- Thermal expansion of solids, liquid, and gases.
- Heat of fusion, vaporization.
- Humidity, absolute and relative.
- Law of cooling.
- Thermoelectricity.
- Thermocouple.

11. **Thermodynamics**
- Heat energy and internal energy.
- First law of thermodynamics.
- Isometric and adiabatic processes.
- Efficiency of heat engine.
- Second law of thermodynamics (both statements).
- Heat engine and refrigerator.

12. **Transfer of Heat**
- Review modes of transfer of heat.
- Emission and absorption of heat.
- Black Body Radiation.
- Laws of energy distribution.
- Planks Quantum Theory.
- The photoelectric effect.
- X-rays, production, properties, and uses.

13. **Electromagnetic Waves**
- Magnetic field around a current carrying conductor.
- Electric field induced around a changing magnetic flux.
- Moving fields.
- Types of electromagnetic waves.
- Generation of radio waves.
- Spectrum of electromagnetic waves.

14. **Atomic Nucleus**
- Structure of the nucleus.
- Radioactivity.
- Radioactive series.
- Transmutation of elements.
- The fission reaction.
- The fusion reaction.
- The nuclear reactor.

15. **Nuclear Radiations.**
- Properties and interaction with matter.
- Radiation detectors.
- Radiation damage and its effects.
- Radiation therapy.
16. Artificial Satellite
- Review law of gravitation.
- Escape Velocity.
- Orbital Velocity.
- Geosynchronous and geostationary satellites.
- Use of satellites in data communication.

17. Magnetic Materials
- Magnetism.
- Domains theory
- Para, Dia, and Ferromagnetism and magnetic materials.
- B.H. Curve and hysteresis loop.

18. Semiconductor Materials
- Crystalline structure of solids.
- Conductors, semiconductors, insulators.
- P-type and N-type materials.
- P-N junction.
- P-N junction as a diode.
- Photovoltaic cell (solar cell).

DRT 113: Geology

Geology: 4 credits (60 hours); L, P; SPW
1. Geophysics, geochemistry, geomathematics, geoinformatics and geostatistics;
2. Mineralogy, petrology, palaeontology, sedimentology, stratigraphy, structural geology and tectonics;
3. Geomorphology, quaternary studies, soil science,
4. Palaeobiology, palaeoclimatology, palaeoecology and palaeo-oceanography;
5. Basic of hydrology and hydrogeology, environmental geoscience, meteorology, climatology, glaciology and oceanography;
6. Geological, geomorphological and soil mapping, remote sensing applications;
7. Volcanology, ore geology, geomaterials, basic of geotechnics, and economic geology.

DRT 114: Hydrogeology

Hydrogeology: 5 credits (75 hours); L, T, SPW
1. Design of subsurface investigations;
2. Three-point problem solution;
3. Flow net construction and analysis;
4. Use of Darcy’s law and calculation of groundwater velocity;
5. Hydraulic conductivity and intrinsic permeability, calculation and measurement methods;
6. Aquifer types and groundwater occurrence;
7. Storeability and transmissibility, calculation and measurement methods;
8. Vertical groundwater gradients and flow;
9. Hydrologic cycle;
10. Basic statistics and probabilistic methods;
11. Geographic information systems;
12. Aquifer testing.

DRT 115: Introduction To Mechanical Engineering

Introduction To Mechanical Engineering: 4 credits (60 hours); L, P, SPW

1. Basic principles
   - Equivalent force system;
   - Equations of equilibrium;
   - Free body diagram;
   - Reaction;
   - Static indeterminacy.

2. Structures
   - Difference between trusses, frames and beams,
   - Assumptions followed in the analysis of structures;
   - 2D truss;
   - Method of joints;
   - Method of section

3. Frame: Simple beam
   - Types of loading and supports;
   - Shear Force and bending Moment diagram in beams;
   - Relation among load, shear force and bending moment.

4. Friction
   - Dry friction;
   - Description and applications of friction in wedges, thrust bearing (disk friction), belt, screw, journal bearing (Axle friction);
   - Rolling resistance.

5. Virtual work and Energy method
   - Virtual Displacement;
   - Principle of virtual work;
   - Applications of virtual work principle to machines;
   - Mechanical efficiency;
   - Work of a force/couple (springs etc.).

6. Potential energy and equilibrium
   - Stability.
Center of Gravity and Moment of Inertia:
- First and second moment of area;
- Radius of gyration;

7. **Parallel axis theorem**
- Product of inertia, Rotation of axes and principal moment of inertia;
- Moment of inertia of simple and composite bodies.
- Mass moment of inertia.

**DRT 116: Basic Electrical Engineering and Measurements**

- **Basic Electrical Engineering and Measurements: 5 credits (75 hours); L, P, SPW**
  1. Introduction (Generation, Transmission and Distribution of Electric Power an Overview)
  2. DC Circuit
  3. R-L & R-C Transients
  4. Single-phase AC Circuits
  5. Three-phase AC Circuits
  6. Magnetic circuits and Core losses
  7. Transformer
  8. Three-phase Induction Motor
  9. DC Machines
  10. Measuring Instruments
  11. Accuracy of measurement and error analysis
  12. Measurement of active power and power factor

**DRT 117: Bilingual training**

- **English : 1.5 credits (22 hours 30mn)); L, T, SPW**
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication.
  4. **Autonomous reading of "writings" of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
C.V;
Letter of motivation;
Letter/memo writing and minutes of a meeting

French : 1.5 credits (22 hours 30mn)); L, T, SPW
4. Vocabulaire
   ▪ Vocabulaire technique usuel
5. Grammaire
   ▪ Du verbe : Conjuguaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   ▪ De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   ▪ Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   ▪ Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   ▪ De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   ▪ Des fonctions grammaticales.
6. Expression et communication
   ▪ Compréhension et interaction au cours d’une discussion technique ;
   ▪ Communication orale courante ;
   ▪ Communication orale interactive ;
   ▪ De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
   ▪ Lecture rapide et compréhension de texte ;
   ▪ Synthèse de texte
   ▪ De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
   ▪ Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
   ▪ Expressions figées

DTR 121: Chemistry

Chemistry: 4 credits (60hours); L, T, P, SPW
1. Fundamental Concepts of chemistry
   ▪ Chemistry in petroleum and chemical industry.
   ▪ Elements, compounds, and mixtures.
   ▪ Atom, atomic weight, molecule, valency, molecular weight.
   ▪ Symbols, formulae, and equations.
   ▪ Molecular formula, and Empirical formula.
- Physical and chemical changes.
- Physical and chemical properties.
- Acids, bases, and salts.
- Law of conservation of mass.
- Law of constant proportion.
- Law of reciprocal proportion.
- Law of multiple proportion.

2. **Structure of Atom and Chemical Bonding**
   - Fundamental particles of atom.
   - Bohr's model of atom and its defects.
   - Energy levels, sub-energy levels and orbitals.
   - Electronic configuration.
   - Ionization potential, electronegativity, and electron affinity.
   - Ionic bond with examples.
   - Covalent bond (polar and non-polar), Sigma and Pi bonds with examples.
   - Coordinate covalent bond with examples.

3. **Physical States of Matter**
   - Physical states of matter, explanation with the help of kinetic molecular theory.
   - Properties of liquids; surface tension, viscosity, capillary action, diffusion.
   - Behavior of gases, kinetic theory of gases.
   - Boyle's and Charles' law, general gas equation, problems relating to these laws.
   - Isomorphism and polymorphism.
   - Amorphous solids.

4. **Metals and Alloys**
   - Metals and non-metals
   - Important ores; properties and uses of Cu, Al, Zn, and Fe Metals.
   - Corrosion; Definition, causes and control.
   - Alloys; introduction.
   - Compositions, properties, and uses of bell metal, stainless steel, and brass.

5. **Water**
   - Sources, chemical nature, and properties of water.
   - Impurities of water.
   - Hardness of water.

6. **Solutions and Colloids**
   - Types of Solutions.
   - Concentration.
   - Solubility.
   - Colloids.
7. **Acid and Base**
   - Concept of acid and base.
   - Properties of acid and base.
   - Strength of acid and base.

8. **Halogens**
   - Introduction to halogens.
   - Preparation, properties, and uses of Chlorine.
   - Preparation, properties, and uses of HC1.

9. **Thermo chemistry**
   - Introduction.
   - Exothermic and endothermic reactions.
   - Heat of reaction.
   - Heat of formation.
   - Heat of combustion.
   - Heat of neutralization.
   - Hess’s law of constant heat summation.

10. **Electrochemistry**
    - Theory of ionization.
    - Solubility product.
    - Electrolytes and electrolysis.
    - Faraday’s laws of electrolysis.
    - Conductivity of electrolytes.
    - pH of solutions and pH scale.
    - Measurement of pH.

11. **Organic Chemistry**
    - Introduction to Organic Chemistry.
    - Classification of hydrocarbons (Alkanes, Alkenes, Alkynes, Naphthene’s, Aromatics).
    - Introduction to Alcohols.
    - Introduction to Alkyl Halides.

❖ **DRT 122 : Computer for Business I and Computer programming**

**Objectives:** at the end of this courses students should achieve knowledge and practical know-how related to computer concepts and programming

❖ **Computer for Business I: 3 credits (30 hours); L, T, P, SPW**
   1. Generalities, impact of computer on society, current notions, basic hardware, software and networking
   2. Procedures in using computer systems
   3. Practical approach - hands-on
   4. MS word; -MS excel; -MS power point; -Ms access
Computer programming: 2 credits (30 hours); L, T, P, PW

1. Generalities on Programming,
2. Delphi and Visual Basic Programming: Visual Basic concepts, Designing programs, Program Flow, Testing and Debugging, Functions, Arrays, Interacting with the user, Interacting with the system;
3. Mastering of professional Software;
4. Algorithms

DRT 123: Basic of hydraulics

Basic of hydraulics: 4 credits (60 hours); L, T, SPW

1. The nature and properties of fluids, forces, and flows;
2. Fluid kinematics and flux of quantities;
3. Conservation of mass – the continuity equation;
4. Conservation of momentum and forces on bodies;
5. Conservation of energy;
6. Dimensional analysis and similarity;
7. Flow in pipes;
8. Discharge measurement in pipes;
9. Pressure surges in pipes;

DRT 124: Geological engineering / Investigation methods for geological and geophysical studies

Geological engineering: 2 credits (30 hours);

1. Fundamentals of Geotechnical Engineering
2. Rock Mechanics
3. Structural geology
4. Applications Of Geographic Information Systems
5. Geological Engineering Field Methods
6. Risk Assessment In Environmental Studies
7. Geomorphology And Terrain Analysis
8. Intermediate Subsurface Hydrology And Contaminant Transport Mechs

Investigation methods for geological and geophysical studies: 2 credits (30 hours)

1. Geological and Geophysical investigation Methods
2. Exploitation of results of geophysical measurements
3. Real case study of electric and Seismic recordings
**DRT125 : Technical evaluation in drilling / Drilling technology**

- Technical evaluation in drilling 3 credits (45 hours);
  1. **Preparations and Well Design Basis**
     - Prospect evaluation
     - Definition of well target
     - Site survey
     - Preparation of geological and pore pressure prognosis
     - Data acquisition program
     - Getting access to rig, rig selection
     - Conceptual well planning
     - HSEQ-program, risk registers, consent to drill application
     - Drilling permit
  2. **Well Construction and Detailed Planning**
     - Detailed well design (casing, mud, bottom hole assembly)
     - Planning for data acquisition
     - Formal Risk Assessment, Hazid
     - Time and cost estimation (AFE)

- Drilling technology: 2 credits (30 hours)
  1. RAB (Rotary Air Blast)
  2. RC (Reverse Circulation)
  3. Diamond drilling

**DRT 126: Internship**

- Internship: 5 credits (75 hours)

**DRT 127: Computer for business II / Civic and moral education**

- Computer for Business II: 1 credit (15 hours); L, T, P, SPW
  1. Revision on: -MS word -MS excel -MS power point -Ms access
  2. Office automation
  3. Graphics and graphing packages
  4. Internet working
  5. Information services

- Civic and Moral Education: 2 credits (30 hours); L, T

  **The Concepts**
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
  - The freedoms;
- The public service;
- Ethics;
- Ethics, Law and reason;
- Ethical Problem;
- Ethics and management.
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics

**DRT 231: Analytical Chemistry I**

- Analytical Chemistry I: 4 credits (60 hours); L, T, P, SPW

**General Objective**
- Understand the principles of analytical separations and their applications
- Understand the principles of spectrophotometric techniques and their applications

**Contents**

1. **The principles of analytical separations and their applications**
   - Describe the principles of extraction using partition coefficients and separate phases.
   - Discuss the effects of pH on extraction
   - Discuss the basic principles of chromatography and types of chromatography (adsorption; partition, ion-exchange; molecular exclusion/gel permeation; affinity chromatography).
   - Understand the fundamental differences between the types of chromatography in above.
   - Calculate the retention time of a solute and its relationship between partition coefficient.
   - Calculate the average volume percent of a compound from the peak areas.
   - Understand the differences between packed and open tubular columns and when they may be used.
   - Discuss the different types of detector used with GC,
   - Discuss the basic principles of HPLC
   - Discuss stationary phases: polar and non polar and understand the difference between normal and reverse phase chromatography
- Discuss the different types of detector: spectrophotometric, refractive index, evaporative lights cattering, electrochemical.
- Discuss the criteria used to optimise separation: capacity factor, resolution, peak shape, operating pressure
- Describe different types of resins and their applications
- Discuss the Donnan equilibrium and its role in ion-exclusion chromatography
- Discuss the principles of ion chromatography for anion analysis
- Discuss the principles of molecular exclusion/gel permeation chromatography
- Discuss the principles of capillary electrophoresis
- Draw a schematic diagram of the apparatus used for capillary electrophoresis
- Discuss the basic principles of electroosmosis
- Calculate the apparent mobility using the electrophoretic mobility and electroosmotic mobility
- Calculate the number of theoretical plates
- Discuss experimental factors affecting the condition of the capillary wall
- Discuss the type of sample injection: hydrodynamic and electrokinetic.
- Discuss the process of stacking and its effect on the resulting chromatogram
- Discuss the type of detectors used with CE and their application
- Discuss the basic principles of Micellar electrokinetic chromatography

2. The principles, applications of Flame photometry, Atomic absorption spectrometry, IR, UV-Visible spectroscopy
   - Explain the principle involved in qualitative identification of substances using flame tests. Describe the three types of emission spectrometry.
   - Explain the error and interferences inherent in flame photometric analysis.
   - Describe the evaluation methods used in flame photometry.
   - Describe methods of preparing sample and stock solutions of standards in flame photometry and others (AAS)
   - Describe the general applications of flame photometry and its limitations in relation to AAS. Explain the working principles of Atomic Absorption Spectrophotometer (AAS).
   - Explain the errors and interferences in AAS.
   - Explain the advantages and disadvantages of AAS over flame photometer.
   - Discuss the use of graphite furnaces and inductively couples plasmas as the method of atomisation
   - Discuss the effect of temperature on AAS including the Boltzmann distribution
   - Discuss the use of background correction and application of AAS
Discuss the types of interference that may occur: spectral, chemical, ionisation.

Explain the fundamental principles of infra-red spectroscopy (highlighting liberation of diatomic molecules and polyatomic molecules).

Classify molecular vibrations.

Describe the characteristic absorption frequency (group frequency) of certain groups in the molecules e.g. -OH; -COOH; -NH2; CO.

Discuss the use of Fourier Transform (Michelson Interferometers).

Describe the preparation of substance for infra-red analysis using Nujol emulsion and KBr pellets etc.

Explain the use of infrared (IR) in elucidation of structure of molecules.

Explain the limitations of IR in analytical work.

Solve problems on IR spectroscopy.

Explain the fundamental principles of UV - Visible absorption spectrometry.

Classify electron transitions with relationship to UV-Visible absorption.

Explain the theory of light - absorption and transmission (Beer - Lambert’s law), A=\varepsilon IC

Describe the spectra of the main classes of organic compounds - alkenes, unsaturated compounds, nitrogen compounds, nitrocompounds, aromatic compounds and heterocyclics.

Illustrate diagrammatically the layout of UV – Visible spectrophotometer (power supply, light sources monochromators, detectors and measuring device).

Describe the optical layout of a double - beam UV – Visible spectrophotometer.

List the advantages of double beam over the single beam spectrophotometer.

Describe sample preparation for UV - Visible analysis with examples

Outline the main applications of colorimetric and spectrophotometric analysis:
- spectrophotometric titration
- determination of pKa
- determination of pH of a given sample.

Explain the terms true fluorescence, phosphorescence, chemiluminescence and bioluminescence.

Differentiate between UV and fluorescence with respect to change in absorption maximum.

Explain how the intensity of fluorescence is proportional to the concentration of the substance in dilute solutions.

Explain the term “quantum yield” and “quenching”

Describe the various units of a spectrofluorimeter e.g. light source, photo-multiplier, recorder and its operation.
• Describe the methods of preparation of a sample for analysis by spectrofluorimetry.
• Explain the applications of fluorimetry and its limitation in analytical work.

❖ DRT 232: Mathematics II

➢ Mathematics II: 5 credits (75 hours); L, T, SPW

1. Functions and Limits
2. Differentiation
3. Differentiation of Algebraic Functions
4. Differentiation of Trigonometric Functions
5. Differentiation of Logarithmic & Exponential Functions
6. Rate of Change of Variables
7. Integration – Simple Basic Rules
8. Methods of Integration
9. Definite Integrals
10. Differential Equations
11. Plane Analytic Geometry & Straight Line
12. Equations of Straight Line
13. Equations of Circle
14. Statistics

❖ DRT 233: Subsurface Hydromechanics / Basic Mechanical Engineering for Mining

➢ Subsurface Hydromechanics: 2 credits (30 hours)

1. Hydrostatics
2. Hydrokinematics
3. Hydrodynamics
4. Pumps used for handling of different fluids
5. Storage tanks (milk silo, tankers, feed tanks, balance tanks etc.)
6. Piping systems for various utilities, pipefitting & valves, flow meters etc
7. Measuring instrument

➢ Basic Mechanical Engineering for Mining: 2 credits (30 hours)

1. Resistance of materials;
2. Stress-strain diagram;
3. Elastic constants and their relations,
4. Thermal stresses and strains. Stresses in oblique planes -Principal Stresses and principal planes.
5. Theory of simple bending; Deflection of beams-integration method and moment area method.
6. Analysis of stresses in pressure vessels.
7. Torsion of solid and hollow circular Shafts.
DRT 234: Identification of different drilling equipment’s / Introduction to rock drilling process

- Identification of different drilling equipment’s: 3 credits (45 hours)
  1. **Cable tool equipment’s**
     - Cable Tool Drill String Components
     - Cable Tool Bailer
     - Cable Tool Casing Driving Equipment
  2. **Auger drilling equipment’s**
  3. **Rotary drilling equipment’s**
     - Prime Movers
     - Hoisting Equipment
     - Rotating Equipment
     - Rotary Drill Bits
     - Circulating System
  4. **Safety equipment**
  5. **Drill pipes, Mud motors**

- Introduction to rock drilling process: 2 credits (30 hours)
  1. Mechanism of Rock Breakage by Drilling
  2. Drilling machinery, hydraulic/pneumatic/others
  3. Drill steels
  4. Rotary-Percussive Drilling
  5. Rotary-Percussive Drilling Accessories
  6. Rotary Drilling
  7. Selection of Rock Drill and Accessories
  8. The importance of precise drilling, the position of the hole, the direction and the depth
  9. Drilling for demolition
  10. Occupational health and safety

DRT 235: Materials Science Technology

- Materials Science Technology: 4 credits (60 hours); L, P, SPW
  1. Introduction to Materials Science and Technology
  2. Classification of Material
  3. Material System
  4. Crystal Study
  5. Metallography and Crystallography
  6. Metals
  7. Physical Metallurgy
  8. Properties of Metal
  9. Ceramics
10. Thermal Shock
11. Glass Bead on a Wire, Glass Bending and Blowing,
12. Standard Glass Batching, Glass Melting, Glass Coloring, Glass Fusin
13. Ceramic Slip Casting, Making Glass from Soil
14. Making and Testing Superconductor
15. Polymers; Composites; Electronic Materials

❖ DRT 236: Basic functional components of Rotary Rig / Setting-up and operating drilling process

➢ Basic functional components of Rotary Rig: 3 credits (45 hours)
   1. Pipe handling system and storage
   2. Drill floor and substructure w/equipment
   3. Bulk system
   4. Mud mixing and storage system
   5. High pressure mud system
   6. Drilling data acquisition system

➢ Setting-up and operating drilling process: 2 credits (30 hours)
   1. Drilling planning
   2. Principles of Drilling Fluid Technology
   3. Principles of Borehole Stability-Rig
   4. Principles of Hydraulic Testing

❖ DRT 237: Accounting and labor law

➢ Accounting: 2 credits (30 hours); L, T, SPW
   1. Generality on analytical accounting and business management
      ▪ Objective;
      ▪ Role;
      ▪ Concept of burden.
   2. Analysis of expenses
      ▪ Liable burdens;
      ▪ Direct and indirect expenses;
      ▪ Valorisation of stocks.
   3. Method of full costs
      ▪ Cost of purchase;
      ▪ Cost of production;
      ▪ Cost of returns;
      ▪ Calculation of the results.

➢ Labor law: 1 credit (15 hours); L, T, SPW

A- First Part
   1. The concept of law
2. The characters of the rule of law
3. The sources of law (the hierarchical standards)
4. The application of the Act (the non-retroactivity of the Act and the territoriality of the law)
5. The judicial institutions (courts, a principle of a double degree of jurisdiction, appeal in cassation)
6. Sanctions for violation of the rule of law (inhibition, execution, repair, repression)

B- Second Part
1. The sources of labor law
2. The different labor contracts (conventional contracts and precarious contracts)
3. Execution of the work contract (payment of salary and claim of salary, different professional sanctions)
4. Dismissal and resignation
5. Resolution of disputes in respect of work

❖ DRT 241: Industrial Safety and safety culture

➢ Industrial Safety and safety culture: 4 credits (60 hours); L, T, SPW

General objective:
Understand the importance of safety in industry, Know the causes and ways of preventing industrial accidents not caused by Fire, Appreciate what is involved in safety inspection, Appreciate the various causes and fire prevention in industry, Know the various methods and proceedings in firefighting, Appreciate the factories act and the principals involved in factory law.

Contents:
importance of safety in industry, causes and ways of preventing industrial accidents not caused by Fire, involvement of safety inspection, causes and fire prevention in industry, methods and proceedings in firefighting, factories act and the principals involved in factory law.

❖ DRT 242: Fluids mechanics

➢ Fluids mechanics: 5 credits (75 hours); L, T, P, SPW

1. Fundamental concepts in fluid mechanics;
2. Characteristics and properties of fluid;
3. Fluid statics:
   - Basic equation of hydrostatics,
   - pressure distribution in a static and constant accelerating fluid,
   - hydrostatic force on plane and curved surfaces immersed in static fluid,
4. Kinematics of fluid motion:
   - Velocity,
   - acceleration,
   - streamlines,
   - stream-tubes,
   - particle paths,
   - streak lines;
5. Definition of irrational and rotational flow;
6. Circulation;
7. Stream function and velocity potential functions for flow in a uniform stream and due to source, sink and doublet and for simple combinations of these.

❖ DRT 243 : Directional drilling and core logging

➢ Directional drilling : 2 credits (30 hours), L,T, P, SPW
   1. Reasons For Directional Drilling/Deviation Control
   2. Well Planning
   3. Requirements to Trajectory Planning
   4. Inclination, Azimuth and Dogleg Severity
   5. Calculation Methods/Models
   6. Surveying and Measurement
   7. Instruments for Directional Measurements
   8. Controlling Hole Inclination

➢ Core logging : 4 credits (60 hours), L,T, P, SPW
   1. Coring
   2. Geological description of the core
   3. Measurement on the core (length, diameter, dip …)
   4. Core storage and transport

❖ DRT 244 : Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment

➢ Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment: 4 credits (60 hours); L, T, P, SPW
   1. Handling systems and equipments Prevention
   2. Operating precautions and inspection requirements before or after use
   3. Inspection and maintenance routine requirements for all handling systems
4. Determination of design load and design safety factors non-purpose-built systems
5. Determination of safe working load
6. User-provided loose gear
7. Load monitoring / indicating syste
8. System installation requirements
9. System commissioning requirements after initial installation
10. Periodic load testing requirements after initial installation and commissioning
11. Third party verification of purpose-built systems

❖ DRT 245: Well Site Preparation & Drilling Safety

➢ Well Site Preparation & Drilling Safety: 4 credits (60 hours); P

1. Site Preparation Safety
   ▪ Levelling the Site, Excavation and Trenching,
   ▪ Transporting Equipment to the Site, Transporting Equipment by Truck
   ▪ Unloading at Drill Site
2. Rigging Up Safety
   ▪ Setting up the Substructure, Setting Up the Rig Floor and Mast or Derrick
   ▪ Installing Handrails, Guardrails, Stairs, Walkways, and Ladders; Installing of the drilling systems
3. Drilling Ahead Safety
   ▪ Handling Tubulars, Preparing Drilling Fluid
   ▪ Starting the Drilling Process
4. Tripping Out/In
5. Casing Operations Safety
6. Maintenance Activities
   ▪ Rig Floor Maintenance, Drilling Line Maintenance, Wire Rope Maintenance, Derrick Equipment Maintenance
   ▪ Mud Circulating System, Electric Generators, Motors and Systems, Engines
7. Well Control Safety
   ▪ Blowout Prevention Program
   ▪ Monitoring and Maintaining Mud System
   ▪ Installing and Testing
   ▪ Maintaining Surface Control System

❖ DRT 246: Professional internship

➢ Professional internship: 6 credits (90 hours); P

1. Arrival and integration in the enterprise
2. Working in an enterprise
3. Holding of the Internship journal
4. Choice of the topic of work in collaboration with the professional trainer and the academic supervisor
5. Elaboration of the research outline
6. Resources to exploit
7. Organization of work
8. Drafting of the report
9. Presentation of the report before a jury

DRT 247: Economics: 3 credits (45 hours); L, T, SPW

- Economics: 3 credits (45 hours); L, T, SPW 1. Economic
  1. Basic Concept of Economics
     - Definition Adam smith, Alfred Marshall, Prof, Robins
     - Natural and Scope.
     - Importance for technicians.
  2. Basic Concept of Economics
     - Utility.
     - Income.
     - Wealth.
     - Saving.
     - Investment.
     - Value.
  3. Demand and Supply
     - Definition.
     - Law of Demand.
     - Definition of Supply.
     - Law of Supply.
  4. Factors of Production
     - Land.
     - Labor.
     - Capital.
     - Organization.
  5. Business Organization
     - Sole Proprietorship.
     - Partnership.
     - Joint Stock company
  6. Entrepreneurial Skills
     - Preparing, planning, establishing, managing, operating, and evaluating relevant resources in small business.
     - Business opportunities, goal setting.
     - Organizing, evaluating, and analyzing opportunity and risk tasks.
  7. Scale of Production
     - Meaning and its determination.
- Large scale production.
- Small scale production.

8. **Economic Systems**
   - Free economic system.
   - Centrally planned economy.
   - Mixed economic system.

9. **Money**
   - Barter system and its inconveniences.
   - Definition of money and its functions.

10. **Bank**
    - Definition.
    - Functions of a commercial bank.
    - Central bank and its functions.

11. **Cheque**
    - Definition.
    - Characteristics and kinds of cheques.
    - Dishonor of cheque.

12. **Financial Institutions**
    - IMF.
    - IDBP.
    - PIDC.

13. **Trade Union**
    - Introduction and brief history.
    - Objectives, merits, and demerits.
    - Problems of industrial labour.

14. **International Trade**
    - Introduction.
    - Advantages and disadvantages.

15. **Management**
    - Meaning.
    - Functions of management.

16. **Advertisement**
    - The concept, benefits, and drawbacks.
    - Principal media used in business world.

17. **Economy of Cameroon**
    - Introduction.
    - Economic problems and remedies
Field: PETROLEUM AND MINING ENGINEERING

Specialty:
QUARRIES OPERATIONS
1. The objective of the training

The objectives of this course are to produce skilled manpower for the deployment at any surface mining project and develop the knowledge and operating skills of the trainees on quarries operations.

2. Research Skills

→ Generic skills
- Work independently, collaborate as a team;
- Analysis and synthesis of professional documents (French, English);
- Oral, written and corporate communication skills within and without (French, English);
- Participate /engage in the management of the project;
- Know and make use of professional networks and institutions of quarries sectors.

➢ Specific skills
- Identify the different types of surface mining methods
- Identify the different industrial minerals and rocks
- Identify the name and functions of various drilling equipments and their uses.
- Operate and maintain Top-hammer drills including start-up/Shut-down, positioning, vertical drilling, angle-drilling, drill rod changing, and drill rod retrieval
- Operate and maintain Down-the-Hole drills including start-up/shut-down, positioning, drilling, for drilling
- Operate and maintain Jack-hammer/Hand-held drills including start-up/shut-down, rock drilling, rod retrieval
- Operations and handling of Air Compressors, including start-up/shut-down, oiling/greasing, filter changing, pressure maintenance
- Exploratory core drilling operations for mineral explorations and resource evaluations
- Usage and preparation of High explosives and blasting agent
3. Career opportunities

- Cement factories
- Marble and Granite quarries
- Construction companies
- Mineral exploration companies
- Geotechnical services companies
- Reko-Diq copper/gold project
4. Organization of teachings

- FIRST SEMESTER

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5. Courses content

❖ QOP 111: Mathematics I

Mathematics I: 4 credits (60 hours); L, T, SPW

1. Quadratic Equations
2. Arithmetic Progression and Series
3. Geometric Progression and Series
4. Binomial Theorem
5. Partial Fraction
6. Fundamentals of Trigonometry
7. Trigonometric Functions and Ratios
8. General Identities
9. Solution of Triangles
10. Mensuration of Solids
11. Vectors
12. Matrices and Determinants

❖ QOP 112: Physics

Physics: 5 credits (75 hours); L, T, P, SPW

1. Measurements
   - Fundamental units and derived units.
   - Systems of measurement and S.I Units.
   - Concept of dimensions, dimensional formula.
   - Conversion from one system to another.
   - Significant Figures.
2. Scalars and Vectors
   - Revision of head to tail rule.
   - Laws of parallelogram, triangle, and polygon of forces.
   - Resolution of a vector.
   - Addition of vectors by rectangular components.
   - Multiplication of two vectors, dot product and cross product.
3. Motion
   - Review of laws and equations of motion.
   - Law of conservation of momentum.
   - Angular motion.
   - Relation between linear and angular motion.
   - Centripetal acceleration and force.
   - Equations of angular motion.
4. Torque, Equilibrium, and Rotational Inertia
   - Torque.
   - Center of gravity and center of mass.
- Equilibrium and its conditions.
- Torque and angular acceleration.
- Rotational inertia.

5. **Wave Motion.**
   - Review Hook's law of elasticity.
   - Motion under an elastic restoring force.
   - Characteristics of simple harmonic motion.
   - S.H.M and circular motion.
   - Simple pendulum.
   - Wave form of S.H.M.
   - Resonance.
   - Transverse vibration of a stretched string.

6. **Sound**
   - Longitudinal Waves.
   - Intensity, loudness, pitch, and quality of sound.
   - Units of intensity of level and frequency response of ear.
   - Interference of sound waves, silence zones, beats.
   - Acoustics.
   - Doppler Effect.

7. **Light**
   - Review law of reflection and refraction
   - Image formation by mirrors and lenses.
   - Optical instruments.
   - Wave theory of light.
   - Interface, diffraction, polarization of light waves.
   - Applications of polarization in sunglasses, optical activity and stress analysis.

8. **Optical Fiber**
   - Optical communication and problems.
   - Review total internal reflection and critical angle.
   - Structure of optical fiber.
   - Fiber material and manufacture.
   - Optical fiber – Uses.

9. **Lasers**
   - Corpuscular theory of light.
   - Emission and absorption of light.
   - Stimulated absorption and absorption of light.
   - Laser principle.
   - Structure and working of lasers.
   - Types of lasers with brief description.
   - Applications, basic concepts.
   - Material processing.
   - Laser welding.
   - Laser assisted machining.
   - Micro matching.
- Drilling, scribing and making.
- Printing.
- Laser in medicines.

10. **Heat**
- Review of calorimeter and gas laws.
- Thermal expansion of solids, liquid, and gases.
- Heat of fusion, vaporization.
- Humidity, absolute and relative.
- Law of cooling.
- Thermoelectricity.
- Thermocouple.

11. **Thermodynamics**
- Heat energy and internal energy.
- First law of thermodynamics.
- Isometric and adiabatic processes.
- Efficiency of heat engine.
- Second law of thermodynamics (both statements).
- Heat engine and refrigerator.

12. **Transfer of Heat**
- Review modes of transfer of heat.
- Emission and absorption of heat.
- Black Body Radiation.
- Laws of energy distribution.
- Planks Quantum Theory.
- The photoelectric effect.
- X-rays, production, properties, and uses.

13. **Electromagnetic Waves**
- Magnetic field around a current carrying conductor.
- Electric field induced around a changing magnetic flux.
- Moving fields.
- Types of electromagnetic waves.
- Generation of radio waves.
- Spectrum of electromagnetic waves.

14. **Atomic Nucleus**
- Structure of the nucleus.
- Radioactivity.
- Radioactive series.
- Transmutation of elements.
- The fission reaction.
- The fusion reaction.
- The nuclear reactor.

15. **Nuclear Radiations.**
- Properties and interaction with matter.
- Radiation detectors.
- Radiation damage and its effects.
- Radiation therapy
- Radioactive tracers.
- Application of radiation techniques in archeology, agriculture, chemical industry, polymerization, sterilization, food preservation, gauging and control, radioactivity.

16. **Artificial Satellite**
- Review law of gravitation.
- Escape Velocity.
- Orbital Velocity.
- Geosynchronous and geostationary satellites.
- Use of satellites in data communication.

17. **Magnetic Materials**
- Magnetism.
- Domains theory
- Para, Dia, and Ferromagnetism and magnetic materials.
- B.H. Curve and hysteresis loop.

18. **Semiconductor Materials**
- Crystalline structure of solids.
- Conductors, semiconductors, insulators.
- P-type and N-type materials.
- P-N junction.
- P-N junction as a diode.
- Photovoltaic cell (solar cell).

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**QOP 113: General Geology**

- **General Geology: 4 credits (60 hours); L, P; SPW**
  1. Geophysics, geochemistry, geomathematics, geoinformatics and geostatistics;
  2. Mineralogy, petrology, palaeontology, sedimentology, stratigraphy, structural geology and tectonics;
  3. Geomorphology, quaternary studies, soil science,
  4. Palaeobiology, palaeoclimatology, palaeoecology and palaeo-oceanography;
  5. Basic of hydrology and hydrogeology, environmental geoscience, meteorology, climatology, glaciology and oceanography;
  6. Geological, geomorphological and soil mapping, remote sensing applications;
  7. Volcanology, ore geology, geomaterials, basic of geotechnics, and economic geology.
QOP 114: Rock Mechanics / Structural Geology

- **Rock Mechanics**: 3 credits (45 hours); L, T, SPW
  1. Rock material and rock masses
  2. Primary Rock Types By Geologic Origin
  3. Index Properties Of Intact Rock
  4. Specific Gravity Of Rock Minerals
  5. Fundamental concepts and description of fissures
  6. Quantitative Classification Of Rock Mass, Classification For Rock Material Strength, Intact Rock Classification
  7. Physical and mechanical properties of rock material
  8. Residual stresses in rock masses in situ
  9. Strains, modulus of deformation and failure in rock masses
  10. Interstitial water in rock material and rock masses

- **Structural Geology**: 2 credits (30 hours); L, T, SPW
  1. Principles of rock deformation
  2. Geometry of rock structures
  3. Structural Features On Discontinuities:-Bedding-Planes, -Folds, -Faults,-Joint Patterns
  4. Fabrics: grain-scale structure
  5. Design In Rock: Dip Angle, Dip Direction
  7. Structural classification of rocks

QOP 115: Basic Mechanical Engineering for Mining/ Basic Electrical and electronic Engineering

- **Basic Mechanical Engineering for Mining**: 2 credits (30 hours)
  1. Introduction to Strength of Materials;
  2. Stress-strain diagram;
  3. Elastic constants and their relations,
  4. Thermal stresses and strains, Stresses in oblique planes
  5. Principal stresses and principal planes.
  6. Theory of simple bending; Deflection of beams-integration method and moment area method.
  7. Analysis of stresses in pressure vessels-thin and thick cylinders.
  8. Torsion of solid and hollow circular Shafts.
  9. Introduction to theory of Machines; Basic concepts: degrees of freedom, kinematic constrains, linkages, mechanisms.
  10. Different types of gears, gear trains, reduction ratio and torque assessment, application of gearboxes.
  11. Basic principles and constructions of governors, flywheels, brakes, clutches and dynamometers.
Basic Electrical and electronic Engineering: 2 credits (30 hours)

1. Introduction (Generation, Transmission and Distribution of Electric Power, an Overview)
2. DC Circuit
3. Single-phase AC Circuits; Three-phase AC Circuits
4. Electric Fields and Capacitors
5. Electromagnetism
6. Alternating Quantities
7. Magnetic circuits and Core losses
8. Transformer
9. Three-phase Induction Motor
10. DC Machines
11. DC Transients
12. Semiconductor Theory and Devices

QOP 116: Materials Science Technology

Materials Science Technology: 5 credits (75 hours); L, P, SPW

1. Introduction to Materials Science and Technology
   - Classification of Materials
   - Material System
   - Crystal Study
2. Metallography and Crystallography
3. Metals
4. Physical Metallurgy
   - Properties of Metal
   - Alloying Copper and Zing, Alloying Tin and Lead, Alloying Sterling Silver,
   - Aluminum-Zinc Solid-State Phase Change in Metals
   - Caloric Output of Al-Zn: A Solid-State Phase Change in Metals
5. Ceramics
   - Thermal Shock
   - Glass Bead on a Wire, Glass Bending and Blowing,
   - Standard Glass Batching, Glass Melting, Glass Coloring, Glass Fusin
   - Ceramic Slip Casting, Making Glass from sand
6. Making and Testing Superconductor
7. Polymers; Composites; Electronic Materials Technology

QOP 117: Bilingual training

English: 1.5 credits (22 hours 30mn)); L, T, SPW

1. Vocabulary
   - Technical and usual vocabulary of the specialty
2. Grammar
3. **Bilingual expression**
   - Understanding in interaction in Technical Discussions
   - Continuous oral communication: Show, explain, develop, summarize, account, comment;
   - Interactions oral communication.

4. **Autonomous reading of “writings” of all levels**
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
   - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. **Write clear, detailed texts**
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

- **French : 1.5 credits (22 hours 30mn)); L, T, SPW**

1. **Vocabulaire**
   - Vocabulaire du matériel de **technologie agro-alimentaire**
   - Vocabulaire des **produits agro-alimentaires**
   - Vocabulaire des **activités agro-alimentaires**
   - Vocabulaire des **actants**
   - Vocabulaire des **affaires**

2. **Grammaire**
   - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   - Des fonctions grammaticales.

3. **Expression et communication**
   - Compréhension et interaction au cours d’une discussion technique ;
   - Communication orale courante ;
   - Communication orale interactive ;
   - De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
   - Lecture rapide et compréhension de texte ;
   - Synthèse de texte
• De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
• Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
• Expressions figées

❖ QOP 121: Chemistry

➢ Chemistry: 4 credits (60hours): L, T, P, SPW

1. Fundamental Concepts of chemistry
   • Chemistry in petroleum and chemical industry.
   • Elements, compounds, and mixtures.
   • Atom, atomic weight, molecule, valency, molecular weight.
   • Symbols, formulae, and equations.
   • Molecular formula, and Empirical formula.
   • Physical and chemical changes.
   • Physical and chemical properties.
   • Acids, bases, and salts.
   • Law of conservation of mass.
   • Law of constant proportion.
   • Law of reciprocal proportion.
   • Law of multiple proportion.

2. Structure of Atom and Chemical Bonding
   • Fundamental particles of atom.
   • Bohrs model of atom and its defects.
   • Energy levels, sub-energy levels and orbitals.
   • Electronic configuration.
   • Ionization potential, electronegativity, and electron affinity.
   • Ionic bond with examples.
   • Covalent bond (polar and non polar), Sigma and Pi bonds with examples.
   • Coordinate covalent bond with examples.

3. Physical States of Matter
   • Physical states of matter, explanation with the help of kinetic molecular theory.
   • Properties of liquids; surface tension, viscosity, capillary action, diffusion.
   • Behavior of gases, kinetic theory of gases.
   • Boyle's and Charles law, general gas equation, problems relating to these laws.
   • Graham’s law of diffusion, Dalton’s law of partial pressures and Gay Lussac law.
   • Isomorphism and polymorphism.
   • Amorphous solids.
4. **Metals and Alloys**
   - Metals and non-metals
   - Important ores: properties and uses of Cu, Al, Zn, and Fe Metals.
   - Corrosion: Definition, causes and control.
   - Alloys: introduction.
   - Compositions, properties, and uses of bell metal, stainless steel, and brass.

5. **Water**
   - Sources, chemical nature, and properties of water.
   - Impurities of water.
   - Hardness of water.

6. **Solutions and Colloids**
   - Types of Solutions.
   - Concentration.
   - Solubility.
   - Colloids.

7. **Acid and Base**
   - Concept of acid and base.
   - Properties of acid and base.
   - Strength of acid and base.

8. **Halogenes**
   - Introduction to halogenes.
   - Preparation, properties, and uses of Chlorine.
   - Preparation, properties, and uses of HC1.

9. **Thermochemistry**
   - Introduction.
   - Exothermic and endothermic reactions.
   - Heat of reaction.
   - Heat of formation.
   - Heat of combustion.
   - Heat of neutralization.
   - Hess’s law of constant heat summation.

10. **Electrochemistry**
    - Theory of ionization.
    - Solubility product.
    - Electrolytes and electrolysis.
    - Faraday’s laws of electrolysis.
    - Conductivity of electrolytes.
    - pH of solutions and pH scale.
    - Measurement of pH.

11. **Organic Chemistry**
    - Introduction to Organic Chemistry.
    - Classification of hydrocarbons (Alkanes, Alkenes, Alkynes, Naphthene’s, Aromatics).
    - Introduction to Alcohols.
    - Introduction to Alkyl Halides.
QOP 122 : Computer for Business I and Computer programming

Objectives: at the end of this courses students should achieve knowledge and practical know-how related to computer concepts and programming

- **Computer for Business I: 2 credits (30 hours); L, T, P, SPW**
  1. Generalities, impact of computer on society, current notions, basic hardware, software and networking
  2. Procedures in using computer systems
  3. Practical approach - hands-on
  4. MS word; -MS excel; -MS power point; -Ms access

- **Computer programming: 2 credits (30 hours); L, T, P, PW**
  1. Generalities on Programming ,
  2. Delphi and Visual Basic Programming: Visual Basic concepts, Designing programs, Program Flow, Testing and Debugging, Functions, Arrays, Interacting with the user, Interacting with the system;
  3. Mastering of professional Software;
  4. Algorithms

QOP 123 : Introduction to surface mining operations/ Surface mining method

- **Introduction to surface mining operations**
  1. Mine: Definition and economic importance different types and classification;
  2. Mine life cycle and Mineral deposit: Different types and their classification; Mineral resources of Cameroun
  3. Modes of entry to a mine – shaft, incline, decline, adit and box-cut.
  4. Overview of surface mining: Types of surface mines, unit operations, basic bench geometry, applicability & limitations and advantages & disadvantages.
  5. Different metal mining methods and their applicability & limitations;
  6. Basic concepts of transportation.

- **Surface mining method**
  1. Explanations of open pit mining, opencast mining and quarrying methods
  2. Placer Mining, stream sediments
  3. Terrace mining, Strip mining, Contour strip mining, Auger Mining,
  4. Panning, Sluicing, Dredging, Hydraulic Mining, Heap Leaching, In-situ leaching (ISL)
  5. Metalliferous and non-metalliferous mines
  6. Deposits amenable to surface mining, excavation characteristics ;
7. Surface mining unit operations;
8. Surface mining Machinery and equipment systems

**QOP 124 : Identifications of different industrial rocks and minerals**

- Identifications of different industrial rocks and minerals: 4 credits (60 hours); L, T, P, SPW
  1. Physical and chemical properties of industrial minerals and rocks, and their uses;
  2. Definition of industrial minerals and their classification;
  3. Methodology of mineral characterization
  4. The geology, origin and occurrence of the chief categories and deposits of commercial, non-metallic minerals and rocks;
  5. The industrial requirements of minerals and rocks.
  6. Economics of industrial rocks and minerals;

**QOP 125 : Identification of different drilling equipments used in surface mining /Introduction to rock drilling process**

- Identification of different drilling equipment’s: 3 credits (45 hours); L, T, P, SPW
  1. **Cable tool equipment’s**
     - Cable Tool Drill String Components
     - Cable Tool Bailer
     - Cable Tool Casing Driving Equipment
  2. **Auger drilling equipment’s**
  3. **Rotary drilling equipment’s**
     - Prime Movers
     - Hoisting Equipment
     - Rotating Equipment
     - Rotary Drill Bits
     - Circulating System
  4. **Safety equipment**
  5. **Drill pipes,**
  6. **Mud motors**

- **Introduction to rock drilling process: 2 credits (30 hours); L, T, P, SPW**
  1. Mechanism of Rock Breakage by Drilling
  2. Drilling machinery, hydraulic/pneumatic/others
  3. Drill steels
  4. Rotary-Percussive Drilling
  5. Rotary-Percussive Drilling Accessories
  6. Rotary Drilling
  7. Selection of Rock Drill and Accessories
8. The importance of precise drilling, the position of the hole, the direction and the depth
9. Drilling for demolition
10. Occupational health and safety

❖ QOP 126: Internship

➢ Internship: 5 credits (75 hours)

❖ QOP 127: Computer for business II / Civic and moral education

➢ Computer for Business II: 1 credits (15 hours); L, T, P, SPW

1. Revision on: -MS word -MS excel -MS power point -Ms access
2. office automation
3. graphics and graphing packages
4. internet working
5. information services

➢ Civic and Moral Education: 2 credits (30 hours); L, T

The Concepts

- The citizen;
- The Nation;
- The State;
- Publics Property and collective’s goods;
- The freedoms;
- The public service;
- Ethics;
- Ethics, Law and reason;
- Ethical Problem ;
- Ethics and management.
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics
QOP 231: Mathematics II

Mathematics II: 4 credits (60 hours); L, T, SPW

1. Functions and Limits
2. Differentiation
3. Differentiation of Algebraic Functions
4. Differentiation of Trigonometric Functions
5. Differentiation of Logarithmic & Exponential Function
6. Rate of Change of Variables
7. Integration – Simple Basic Rules
8. Methods of Integration.
9. Definite Integrals
11. Plane Analytic Geometry & Straight Line
12. Equations of Straight Line
13. Equations of Circle
14. Statistics

QOP 232: Mineralogy

Mineralogy : 5 credits (75 hours); L, T, P, SPW

1. Geometric crystallography;
2. The mineral and its properties;
3. The silicate minerals and non-silicates

QOP 233: Drilling Operations

Drilling Operations: 4 credits (60 hours); L, T, P, SPW

1. Criteria for selecting drills, Drill steel selection
2. Site preparation, Setup & Collaring
3. Bit regrinding, Drill-hole deviation, Prior sub-drill zone
4. Dust prevention, Mud seams and shears
5. Flushing of drill-cuttings
6. Very jointed rock, Soft or weathered rock
7. Measured data during drilling
8. Sources of drilling error
9. Drilling data from shotfirer (or blasting manager) to driller: drill plan (pattern, hole size), depth (sub drilling), inclination of the bore holes, environment and hazardous situations during drilling.
10. Measuring drill hole position and path
QOP 234: Introduction to explosives and blasting/Safety precautions in the mining sector, handling of explosives and Storage of explosives and detonators

- Introduction to explosives and blasting: 3 credits (45 hours)
  1. Chemistry of explosives and the physics of detonation of explosives
  2. Mechanism of rock breaking with explosives
  3. Generic types of explosives
  4. Physical properties of explosives.
  5. Initiation systems of explosive rock breaking
  6. Blast designs for surface mines, blast designs for tunneling, blast design for stopping of various mining methods
  8. Legal Requirements for Explosives

- Safety precautions in mining, handling of explosives and Storage of explosives and detonators: 2 credits (30 hours)
  1. Blasting Falls of Rock, Secondary Blasting, Firing Shots
  2. Handling Misfires, Prevention of Misfires
  3. Loading Bore Holes, Tamping Bore Holes
  4. Making and Handling Primers, Returning to the Face,
  5. Security of Explosives, Opening Cases of Explosives, Disposal of empty cases and deteriorated explosives
  6. Custody of explosives, Explosives Supervisors, Organization of Operations;
  7. Blasting specification, Blasting contractors,
  8. Shotfiring procedures, Shotfiring equipment, Shotfiring Operations, Training of Shotfirers
  9. Use of safety fuse, Safe use of explosives
  10. Storage,
  11. Use of vehicles to transport explosives,
  12. Provision and maintenance of equipment, Transportation from Magazine to Working Face Appointments and authorisations

QOP 235: Blasting Operations

- Blasting Operations: 4 credits (60 hours): L, P, SPW
  1. Principles of blasting
  2. Methods of blast initiation
  3. Blast design, air blast and vibration
  4. Blasting Free Body Diagram, Shot Planning
  5. Rock Breakage Mechanism, Rock Blasting Basics
6. Blasting Geometry and Blast Calculations
7. Hole Spacing and Timing, Affects of Blast Timing
8. Smooth Blasting and Presplitting
9. Environmental Impacts from Blasting
10. Ground Vibrations from Blasting, Common Vibration Thresholds
11. Ground Vibrations and Airblasts,

❖ QOP 236: Loading and Transportations operations

➢ Loading and Transportations operations: 5 credits (75 hours): L, P, SPW

1. Quarry layout: extraction face, sorting and selection, secondary breakage, stockpiling, loading areas.
2. Selection, sorting and loading processing,
3. Mechanical Loaders
4. Loading trucks or trains at the quarry
5. Front-end loaders or hydraulic shovels
6. Factors determining the preference of loading equipment
7. Handling and transport at the quarry: Choosing loaders and trucks, placing wire loops in stones, Road Haultage and rail Haulage.

❖ QOP 237: Accounting and labor law

➢ Accounting: 2 credits (30 hours); L, T, SPW

1. Generality on analytical accounting and business management
   - Objective;
   - Role;
   - Concept of burden.
2. Analysis of expenses
   - Liable burdens;
   - Direct and indirect expenses;
   - Valorisation of stocks.
3. Method of full costs
   - Cost of purchase;
   - Cost of production;
   - Cost of returns;
   - Calculation of the results.

➢ Labor law: 1 credit (15 hours); L, T, SPW

A- First Part
1. The concept of law
2. The characters of the rule of law
3. The sources of law (the hierarchical standards)
4. The application of the Act (the non-retroactivity of the Act and the territoriality of the law)
5. The judicial institutions (courts, a principle of a double degree of jurisdiction, appeal in cassation)
6. Sanctions for violation of the rule of law (inhibition, execution, repair, repression)

B- Second Part
1. The sources of labor law
2. The different labor contracts (conventional contracts and precarious contracts)
3. Execution of the work contract (payment of salary and claim of salary, different professional sanctions)
4. Dismissal and resignation
5. Resolution of disputes in respect of work

❖ QOP 241: Industrial Safety and safety culture

➢ Industrial Safety and safety culture: 4 credits (60 hours); L, T, SPW

General objective:
Understand the importance of safety in industry, Know the causes and ways of preventing industrial accidents not caused by Fire, Appreciate what is involved in safety inspection, Appreciate the various causes and fire prevention in industry, Know the various methods and proceedings in firefighting, Appreciate the factories act and the principals involved in factory law.

Contents:
importance of safety in industry, causes and ways of preventing industrial accidents not caused by Fire, involvement of safety inspection, causes and fire prevention in industry, methods and proceedings in firefighting, factories act and the principals involved in factory law.

❖ QOP 242 : Petrography

➢ Petrography: 5 credits (75 hours); L, T, P, SPW

1. Endogenous Petrography
   ▪ The metamorphism and metamorphic rocks;
   ▪ Magmatism and igneous rocks.
2. Exogenous Petrography
   ▪ The sedimentary phenomenon and the different groups of sedimentary rocks
QOP 243: Preventive maintenance of Loading and Transportations equipments

- Preventive maintenance of Loading and Transportations equipments: 4 credits (60 hours); L, T, P, SPW

1. Diagnostic Maintenance and Condition Monitoring
2. Planned preventive maintenance.
3. Autonomous maintenance.
4. Fluid Power System control
5. Automation and Control
6. Test For Integrity of the System
7. Housekeeping and organization

QOP 244: Crushing Operations

- Crushing Operations: 4 credits (60 hours); L, T, P, SPW

1. The Rock Crusher: Primary Unit, Secondary Unit, Screens, Conveyors
2. Stationary And Mobile Crushing Stations
3. Quarry Crusher Installation
4. Wash Plant And Plant Layout: Equipment Configuration, Drainage, Prevailing Winds, Organization Space, Material Handling, Road Networks, Plant Setup,
5. Crushing Methods: Scalping, Primary Crushing, Secondary And Tertiary Crushing, Impact of Crushing
6. Screening: Product Quality, Gradation Control
8. Stockpiling And Handling: Cone Stockpiles, Radial Stockpiles, Truck-Built Stockpiles, Layered Stockpiles, Stockpiling - General
9. Maintenance of Crushing Equipment
10. Crushing Products

QOP 245: Health, Safety and Environment (HSE)

- Health, Safety and Environment (HSE): 4 credits (60 hours); L, P

1. General duties
2. Surveyors and plans
3. Registration and record-keeping
4. Safety training-Machinery and plant
5. Electrical apparatus
6. Safety of Surface buildings and structures
7. Fire protection and fire-fighting
8. Explosives and shotfiring
9. Drilling and rotary jet piercing - Excavation and loading
10. Dredges and other floating installations
11. Mobile and travelling cranes
12. Hazards in the working environment and environmental protection
13. Recording and notification of accidents, notifiable diseases and dangerous occurrences
14. Consultation on health and safety - First aid and medical services
15. General welfare - Protective clothing and equipment - Miscellaneous provisions

❖ QOP 246: Professional internship

➢ Professional internship: 6 credits (90 hours); P
   1. Arrival and integration in the enterprise
   2. Working in an enterprise
   3. Holding of the Internship journal
   4. Choice of the topic of work in collaboration with the professional trainer and the academic supervisor
   5. Elaboration of the research outline
   6. Resources to exploit
   7. Organization of work
   8. Drafting of the report
   9. Presentation of the report before a jury

❖ QOP 247: Economics

➢ Economics: 3 credits (45 hours); L, T, SPW 1. Economic

  1. Basic Concept of Economics
     ▪ Definition Adam smith, Alfred Marshall, Prof, Robins
     ▪ Natural and Scope.
     ▪ Importance for technicians.
  2. Basic Concept of Economics
     ▪ Utility.
     ▪ Income.
     ▪ Wealth.
     ▪ Saving.
     ▪ Investment.
     ▪ Value.
  3. Demand and Supply
     ▪ Definition.
     ▪ Law of Demand.
• Definition of Supply.
• Law of Supply.

4. **Factors of Production**
   • Land.
   • Labor.
   • Capital.
   • Organization.

5. **Business Organization**
   • Sole Proprietorship.
   • Partnership.
   • Joint Stock company

6. **Entrepreneurial Skills**
   • Preparing, planning, establishing, managing, operating, and evaluating relevant resources in small business.
   • Business opportunities, goal setting.
   • Organizing, evaluating, and analyzing opportunity and risk tasks.

7. **Scale of Production**
   • Meaning and its determination.
   • Large scale production.
   • Small scale production.

8. **Economic Systems**
   • Free economic system.
   • Centrally planned economy.
   • Mixed economic system.

9. **Money**
   • Barter system and its inconveniences.
   • Definition of money and its functions.

10. **Bank**
    • Definition.
    • Functions of a commercial bank.
    • Central bank and its functions.

11. **Cheque**
    • Definition.
    • Characteristics and kinds of cheques.
    • Dishonor of cheque.

12. **Financial Institutions**
    • IMF.
    • IDBP.
    • PIDC.

13. **Trade Union**
    • Introduction and brief history.
    • Objectives, merits, and demerits.
    • Problems of industrial labour.

14. **International Trade**
    • Introduction.
15. **Management**
   - Meaning.
   - Functions of management.

16. **Advertisement**
   - The concept, benefits, and drawbacks.
   - Principal media used in business world.

17. **Economy of Cameroon**
   - Introduction.
   - Economic problems and remedies
Field: PETROLEUM AND MINING ENGINEERING

Specialty: PETROLEUM SYSTEMS AND EXPLOITATION
1. The objective of the training

This specialty leads to the training of specialists capable to organize, administer and control a research or study site. They act upstream of the extractive industries of oil and gas industry.

2. Research Skills

→ General skills
   - Work independently or collaborate in a team;
   - Analyze and synthesize professional document (French, English);
   - Communicate orally, in writing, in company or outside (French, English);
   - Participate in a project management process;
   - Know and exploit the professional and institutional networks of oil and gas sectors.

→ Specific skills
   - Contribute to the development of the technical file of a study;
   - Participate in administrative, social and legal procedures;
   - Participate in the elaboration of the estimate of an operation from the technical file;
   - Contribute to the physical preparation of a construction site;
   - Have the installation skill of a construction site;
   - Have the work done in accordance with the specifications;
   - Ensure the smooth running and good management of the site.

3. Career opportunities

   - The sectors that use or enhance the soil and subsoil (oil and gas exploration and production);
4. Organization of teachings

- **FIRST SEMESTER**

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### THIRD SEMESTER

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**Specialty:** Petroleum System and Exploitation

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### FOURTH SEMESTER

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**Specialty:** Petroleum System and Exploitation

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5. Courses content

❖ PSE 111: Mathematics

Mathematics: 4 credits (60 hours); L, T, SPW

1. Quadratic Equations
2. Arithmetic Progression and Series
3. Geometric Progression and Series
4. Binomial Theorem
5. Partial Fraction
6. Fundamentals of Trigonometry
7. Trigonometric Functions and Ratios
8. General Identities
9. Solution of Triangles
10. Mensuration of Solids
11. Vectors
12. Matrices and Determinants

❖ PSE 112: Physics

Physics: 5 credits (75 hours); L, T, P, SPW

1. Measurements
   - Fundamental units and derived units.
   - Systems of measurement and S.I Units.
   - Concept of dimensions, dimensional formula.
   - Conversion from one system to another.
   - Significant Figures.

2. Scalars and Vectors
   - Revision of head to tail rule.
   - Laws of parallelogram, triangle, and polygon of forces.
   - Resolution of a vector.
   - Addition of vectors by rectangular components.
   - Multiplication of two vectors, dot product and cross product.

3. Motion
   - Review of laws and equations of motion.
   - Law of conservation of momentum.
   - Angular motion.
   - Relation between linear and angular motion.
   - Centripetal acceleration and force.
   - Equations of angular motion.

4. Torque, Equilibrium, and Rotational Inertia
   - Torque.
   - Center of gravity and center of mass.
5. **Wave Motion.**
   - Review Hooks law of elasticity.
   - Motion under an elastic restoring force.
   - Characteristics of simple harmonic motion.
   - S.H.M and circular motion.
   - Simple pendulum.
   - Wave form of S.H.M.
   - Resonance.
   - Transverse vibration of a stretched string.

6. **Sound**
   - Longitudinal Waves.
   - Intensity, loudness, pitch, and quality of sound.
   - Units of intensity of level and frequency response of ear.
   - Interference of sound waves, silence zones, beats.
   - Acoustics.
   - Doppler Effect.

7. **Light**
   - Review law of reflection and refraction
   - Image formation by mirrors and lenses.
   - Optical instruments.
   - Wave theory of light.
   - Interface, diffraction, polarization of light waves.
   - Applications of polarization in sun glasses, optical activity and stress analysis.

8. **Optical Fiber**
   - Optical communication and problems.
   - Review total internal reflection and critical angle.
   - Structure of optical fiber.
   - Fiber material and manufacture.
   - Optical fiber –Uses.

9. **Lasers**
   - Corpuscular theory of light.
   - Emission and absorption of light.
   - Stimulated absorption and absorption of light.
   - Laser principle.
   - Structure and working of lasers.
   - Types of lasers with brief description.
   - Applications, basic concepts.
   - Material processing.
   - Laser welding.
   - Laser assisted machining.
   - Micro matching.
- Drilling, scribing and making.
- Printing.
- Laser in medicines.

10. Heat
- Review of calorimeter and gas laws.
- Thermal expansion of solids, liquid, and gases.
- Heat of fusion, vaporization.
- Humidity, absolute and relative.
- Law of cooling.
- Thermoelectricity.
- Thermocouple.

11. Thermodynamics
- Heat energy and internal energy.
- First law of thermodynamics.
- Isometric and adiabatic processes.
- Efficiency of heat engine.
- Second law of thermodynamics (both statements).
- Heat engine and refrigerator.

12. Transfer of Heat
- Review modes of transfer of heat.
- Emission and absorption of heat.
- Black Body Radiation.
- Laws of energy distribution.
- Planks Quantum Theory.
- The photoelectric effect.
- X-rays, production, properties, and uses.

13. Electromagnetic Waves
- Magnetic field around a current carrying conductor.
- Electric field induced around a changing magnetic flux.
- Moving fields.
- Types of electromagnetic waves.
- Generation of radio waves.
- Spectrum of electromagnetic waves.

14. Atomic Nucleus
- Structure of the nucleus.
- Radioactivity.
- Radioactive series.
- Transmutation of elements.
- The fission reaction.
- The fusion reaction.
- The nuclear reactor.

15. Nuclear Radiations.
- Properties and interaction with matter.
- Radiation detectors.
- Radiation damage and its effects.
16. **Artificial Satellite**
- Review law of gravitation.
- Escape Velocity.
- Orbital Velocity.
- Geosynchronous and geostationary satellites.
- Use of satellites in data communication.

17. **Magnetic Materials**
- Magnetism.
- Domains theory
- Para, Dia, and Ferromagnetism and magnetic materials.
- B.H. Curve and hysteresis loop.

18. **Semiconductor Materials**
- Crystalline structure of solids.
- Conductors, semiconductors, insulators.
- P-type and N-type materials.
- P-N junction.
- P-N junction as a diode.
- Photovoltaic cell (solar cell).

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**PSE 113: Introduction to Petroleum Engineering/Properties of Petroleum Fluids**

- **Introduction to Petroleum Engineering / Properties of Petroleum Fluids: 4 credits (60 hours); L, P, SPW**

1. **Units of Measurement.**
   - SI System of units and other derived units.
   - Conversion of units.
   - Large and small measures.
   - Simple derived units.
   - Temperature.
   - Pressure, standard and atmospheric.
   - Multiple derived units, Examples.
   - Graphing.

2. **Origin and Composition of Petroleum**
   - The origin of petroleum.
   - The composition of petroleum
PSE 114: Thermodynamics and phase behaviour

Thermodynamics and phase behaviour: 5 credits (75 hours); L, T, SPW

1. Properties of Liquid and Gaseous Petroleum
   ▪ Properties of liquid petroleum.
   ▪ API gravity.
   ▪ Bubble point pressure.
   ▪ Formation volume factor.
   ▪ The solution gas-oil-ratio.
   ▪ The oil viscosity.
   ▪ Flash and differential vaporization.
   ▪ Properties of gaseous petroleum.
   ▪ Wet gas and dry gas.
   ▪ Sour gas and Sweet gas.
   ▪ Gas gravity.
   ▪ Standard condition.
   ▪ Compressibility.

PSE 115: Basic Hydraulics

Basic Hydraulics: 4 credits (60 hours); L, P, SPW

1. The nature and properties of fluids, forces, and flows;
2. Fluid kinematics and flux of quantities;
3. Conservation of mass – the continuity equation;
4. Conservation of momentum and forces on bodies;
5. Conservation of energy;
6. Dimensional analysis and similarity;
7. Flow in pipes;
8. Discharge measurement in pipes;
9. Pressure surges in pipes;

PSE116: Introduction to Petroleum Geology: Sedimentary and reservoir rocks

Introduction to Petroleum Geology: Sedimentary and reservoir rocks: 5 credits (75 hours); L, P, SPW

1. Geology fundamental.
   ▪ Main division of rocks of the earth.
   ▪ Rock Structure (faults and folds).
   ▪ Sediments formation.
   ▪ Geology structures.
   ▪ Unconformity.
2. **Exploration – Looking for Oil**
   - Early techniques.
   - Magnetic Survey.
   - Gravity Survey.
   - Seismic survey.

3. **Reservoir Studies**
   - Reservoir classification
   - Types of reservoirs
   - Initial reservoir pressure
   - Natural production mechanisms.
   - Secondary recovery.
   - Reservoir fluid sampling.
   - Subsurface pressures.
   - Subsurface temperature.

4. **Reservoir Pore Space and Fluid flow.**
   - Porosity.
   - Classification of porosity.
   - Typical porosity values.
   - Quantitative use of porosity data.
   - Permeability.
   - Darcy’s equation.

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**PSE 117: Bilingual training**

- **English**: 1.5 credits (22 hours 30mn)); L, T, SPW
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
     - Continuous oral communication: Show, explain, develop, summarize, account, comment;
     - Interactions oral communication.
  4. **Autonomous reading of “writings” of all levels**
     - Lead by a quick reading to understand the general sense;
     - Browse a text long enough to locate desired information;
     - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.
  5. **Write clear, detailed texts**
     - Essay writing;
     - Application for employment;
• C.V;
• Letter of motivation;
• Letter/memo writing and minutes of a meeting

➢ French: 1.5 credits (22 hours 30mn)); L, T, SPW
  1. Vocabulaire
     • Vocabulaire technique usuel
  2. Grammaire
     • Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
     • De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
     • Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
     • Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
     • De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
     • Des fonctions grammaticales.
  3. Expression et communication
     • Compréhension et interaction au cours d’une discussion technique ;
     • Communication orale courante ;
     • Communication orale interactive ;
     • De la phrase : simple, complexe, composée ; interrogative, déclarative, exclamative et impérative.
     • Lecture rapide et compréhension de texte ;
     • Synthèse de texte
     • De la communication : rédaction de texte, d’instructions, de rapport, d’une correspondance, d’une lettre recommandation ou de motivation, d’une demande d’emploi, d’une demande d’explication, d’une réponse à une demande d’explication, d’un CV ;
     • Gestion d’une table ronde/discussion : la prise de notes, la prise de parole
     • Expressions figées

❖ QOP 121: Chemistry

➢ Chemistry: 5 credits (75 hours); L, T, P, SPW
  1. Fundamental Concepts of chemistry
     • Chemistry in petroleum and chemical industry.
     • Elements, compounds, and mixtures.
     • Atom, atomic weight, molecule, valency, molecular weight.
     • Symbols, formulae, and equations.
     • Molecular formula, and Empirical formula.
- Physical and chemical changes.
- Physical and chemical properties.
- Acids, bases, and salts.
- Law of conservation of mass.
- Law of constant proportion.
- Law of reciprocal proportion.
- Law of multiple proportion.

2. **Structure of Atom and Chemical Bonding**
   - Fundamental particles of atom.
   - Bohr's model of atom and its defects.
   - Energy levels, sub-energy levels and orbitals.
   - Electronic configuration.
   - Ionization potential, electronegativity, and electron affinity.
   - Ionic bond with examples.
   - Covalent bond (polar and non-polar), Sigma and Pi bonds with examples.
   - Coordinate covalent bond with examples.

3. **Physical States of Matter**
   - Physical states of matter, explanation with the help of kinetic molecular theory.
   - Properties of liquids; surface tension, viscosity, capillary action, diffusion.
   - Behavior of gases, kinetic theory of gases.
   - Boyle's and Charles law, general gas equation, problems relating to these laws.
   - Graham's law of diffusion, Dalton's law of partial pressures and Gay Lussac law.
   - Isomorphism and polymorphism.
   - Amorphous solids.

4. **Metals and Alloys**
   - Metals and non-metals
   - Important ores; properties and uses of Cu, Al, Zn, and Fe Metals.
   - Corrosion; Definition, causes and control.
   - Alloys; introduction.
   - Compositions, properties, and uses of bell metal, stainless steel, and brass.

5. **Water**
   - Sources, chemical nature, and properties of water.
   - Impurities of water.
   - Hardness of water.

6. **Solutions and Colloids**
   - Types of Solutions.
   - Concentration.
   - Solubility.
   - Colloids.
7. **Acid and Base**
   - Concept of acid and base.
   - Properties of acid and base.
   - Strength of acid and base.

8. **Halogens**
   - Introduction to halogens.
   - Preparation, properties, and uses of Chlorine.
   - Preparation, properties, and uses of HC1.

9. **Thermo chemistry**
   - Introduction.
   - Exothermic and endothermic reactions.
   - Heat of reaction.
   - Heat of formation.
   - Heat of combustion.
   - Heat of neutralization.
   - Hess’s law of constant heat summation.

10. **Electrochemistry**
    - Theory of ionization.
    - Solubility product.
    - Electrolytes and electrolysis.
    - Faraday’s laws of electrolysis.
    - Conductivity of electrolytes.
    - pH of solutions and pH scale.
    - Measurement of pH.

11. **Organic Chemistry**
    - Introduction to Organic Chemistry.
    - Classification of hydrocarbons (Alkanes, Alkenes, Alkynes, Naphthene’s, Aromatics).
    - Introduction to Alcohols.
    - Introduction to Alkyl Halides.

**PSE 122 : Computer for Business I and Computer programming**

**Objectives**: at the end of this courses students should achieve knowledge and practical know-how related to computer concepts and programming

- **Computer for Business I: 2 credits (30 hours); L, T, P, SPW**
  1. Generalities, impact of computer on society, current notions, basic hardware, software and networking
  2. Procedures in using computer systems
  3. Practical approach - hands- on
  4. MS word; -MS excel; -MS power point; -Ms access

- **Computer programming: 2 credits (30 hours); L, T, P, PW**
  1. Generalities on Programming ,
2. Delphi and Visual Basic Programming: Visual Basic concepts, Designing programs, Program Flow, Testing and Debugging, Functions, Arrays, Interacting with the user, Interacting with the system;
3. Mastering of professional Software;
4. Algorithms

❖ PSE 123: Petrophysics

➢ Petrophysics: 4 credits (60 hours); L, T, SPW

Fundamental physical properties of single and multiple fluids saturating rocks (including laboratory determination); porosity, permeability, relative permeability, fluid saturations, electrical resistivity, capillary pressure, Surface tension, Wet ability, Compressibility and correlations between rock properties. Mechanical properties of reservoir rocks: Rock mechanic parameters (Poisson's ratio, Young's modulus, Modulus of rigidity and Bulk modulus), Darcy’s law and its applications.

❖ PSE 124: Petroleum Exploration Technics: 4 credits (60 hours); L, T, SPW

➢ Petroleum Exploration Technics: 4 credits (60 hours); L, T, SPW
   1. Direct Indications
   2. Geological Methods
   3. Geophysics methods apply for petroleum exploration
   4. Seismic method for petroleum industry (materials, technics and interpretation)

❖ PSE 125: Strenght of Materials

➢ Strenght of Materials: 5 credits (75 hours); L, P, SPW
   1. Model and dimension a beam subjected to bending
   2. torsion, deflection of the beam
   3. notion of stresses
   4. Use and understand the criteria of elastic resistance
   5. Choose a factor of safety
   6. Calculate contact pressures in simple cases

❖ PSE 126: Introduction to Drilling Technology

➢ Introduction to Drilling Technology: 5 credits (75 hours); L, P, SPW
   1. Rotary Drilling
      ▪ Basic rig components.
      ▪ Basic rotary drilling operations.
      ▪ Hoisting System
      ▪ Rotating System
      ▪ Circulating System
      ▪ Well Control System
- Power System
- Calculations.

2. **Drilling Fluids**
- Functions of drilling fluids.
- Properties of drilling fluids.
- Types of drilling fluids.
- Drilling hazards
- Drilling mud calculations
- Maintenance of mud system

3. **Coring**
- Coring methods and equipment’s.
- Handling and sampling of cores.

4. **Casing and Cementing**
- Function of casing.
- Types of casing.
- Casing specification.
- Casing accessories.
- Introduction to cementing.
- Important factors for good cementing.
- Primary cementing.
- Cement Bonding.
- Squeeze cements.
- Special Cements.
- Evaluation of Cementing Operations.

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**PSE 127: Computer for business II / Civic and moral education**

- **Computer for Business II: 1 credits (15hours); L, T, P, SPW**
  1. Revision on: - MS word - MS excel - MS power point - MS access
  2. office automation
  3. graphics and graphing packages
  4. internet working
  5. information services

- **Civic and Moral Education: 2 credits (30 hours); L, T**

**The Concepts**
- The citizen;
- The Nation;
- The State;
- Publics Property and collective’s goods;
- The freedoms;
- The public service;
- Ethics;
- Ethics, Law and reason;
- Ethical Problem ;
- Ethics and management.
- Civics
- Deontology
- Moral consciousness
- The universal declaration of Human Rights
- Good governance in public services
- The importance of civics to the life of the nation
- Functions of the state and its citizens
- Deontology, Professional ethics and professionalism
- Relationship between morality, law and ethics
- Codes of ethics

❖ PSE 231: Mathematics II

➢ Mathematics II: 4 credits (60 hours); L, T, SPW

1. Functions and Limits
2. Differentiation
3. Differentiation of Algebraic Functions
4. Differentiation of Trigonometric Functions
5. Differentiation of Logarithmic & Exponential Function
6. Rate of Change of Variables
7. Integration – Simple Basic Rules
8. Methods of Integration.
9. Definite Integrals
11. Plane Analytic Geometry & Straight Line
12. Equations of Straight Line
13. Equations of Circle
14. Statistics

❖ PSE232: Analytical Chemistry

➢ Analytical Chemistry: 5 credits (75 hours); L, T, P, SPW

General Objective
- Understand the principles of analytical separations and their applications
- Understand the principles of spectrophotometric techniques and their application

Contents:
1. The principles of analytical separations and their applications
   - Describe the principles of extraction using partition coefficients and separate phases.
   - Discuss the effects of pH on extraction
Discuss the basic principles of chromatography and types of chromatography (adsorption; partition, ion-exchange; molecular exclusion/gel permeation; affinity chromatography).

Understand the fundamental differences between the types of chromatography in above.

Calculate the retention time of a solute and its relationship between partition coefficient.

Calculate the average volume percent of a compound from the peak areas.

Understand the differences between packed and open tubular columns and when they may be used.

Discuss the different types of detector used with GC,

Discuss the basic principles of HPLC

Discuss stationary phases: polar and non polar and understand the difference between normal and reverse phase chromatography

Discuss the different types of detector: spectrophotometric, refractive index, evaporative lights cattering, electrochemical.

Discuss the criteria used to optimise separation: capacity factor, resolution, peak shape, operating pressure

Describe different types of resins and their applications

Discuss the Donnan equilibrium and its role in ion-exclusion chromatography

Discuss the principles of ion chromatography for anion analysis

Discuss the principles of molecular exclusion/gel permeation chromatography

Discuss the principles of capillary electrophoresis

Draw a schematic diagram of the apparatus used for capillary electrophoresis

Discuss the basic principles of electroosmosis

Calculate the apparent mobility using the electrophoretic mobility and electroosmotic mobility

Calculate the number of theoretical plates

Discuss experimental factors affecting the condition of the capillary wall

Discuss the type of sample injection: hydrodynamic and electrokinetic.

Discuss the process of stacking and its effect on the resulting chromatogram

Discuss the type of detectors used with CE and their application

Discuss the basic principles of Micellar electrokinetic chromatography

2. The principles, applications of Flame photometry, Atomic absorption spectrometry, IR, UV-Visible spectroscopy

Explain the principle involved in qualitative identification of substances using flame tests. Describe the three types of emission spectrometry.

Explain the error and interferences inherent in flame photometric analysis.
- Describe the evaluation methods used in flame photometry.
- Describe methods of preparing sample and stock solutions of standards in flame photometry and others (AAS).
- Describe the general applications of flame photometry and its limitations in relation to AAS. Explain the working principles of Atomic Absorption Spectrophotometer (AAS).
- Explain the errors and interferences in AAS.
- Explain the advantages and disadvantages of AAS over flame photometer.
- Discuss the use of graphite furnaces and inductively couples plasmas as the method of atomisation.
- Discuss the effect of temperature on AAS including the Boltzmann distribution.
- Discuss the use of background correction and application of AAS.
- Discuss the types of interference that may occur: spectral, chemical, ionisation.
- Explain the fundamental principles of infra-red spectroscopy (highlighting liberation of diatomic molecules and polyatomic molecules).
- Classify molecular vibrations.
- Describe the characteristic absorption frequency (group frequency) of certain groups in the molecules e.g. -OH; -COOH; -NH2; CO.
- Discuss the use of Fourier Transform (Michelson Interferometers).
- Describe the preparation of substance for infra-red analysis using Nujol emulsion and KBr pellets etc.
- Explain the use of infrared (IR) in elucidation of structure of molecules.
- Explain the limitations of IR in analytical work.
- Solve problems on IR spectroscopy.
- Explain the fundamental principles of UV - Visible absorption spectrometry.
- Classify electron transitions with relationship to UV-Visible absorption.
- Explain the theory of light - absorption and transmission (Beer - Lambert’s law), A=εIC.
- Describe the spectra of the main classes of organic compounds - alkenes, unsaturated compounds, nitrogen compounds, nitrocompounds, aromatic compounds and heterocyclics.
- Illustrate diagrammatically the layout of UV – Visible spectrophotometer (power supply, light sources monochromators, detectors and measuring device).
- Describe the optical layout of a double - beam UV – Visible spectrophotometer.
- List the advantages of double beam over the single beam spectrophotometer.
- Describe sample preparation for UV - Visible analysis with examples.
• Outline the main applications of colorimetric and spectrophotometric analysis:
  − spectrophotometric titration
  − determination of pKa
  − determination of pH of a given sample.
• Explain the terms true fluorescence, phosphorescence, chemiluminescence and bioluminescence.
• Differentiate between UV and fluorescence with respect to change in absorption maximum.
• Explain how the intensity of fluorescence is proportional to the concentration of the substance in dilute solutions.
• Explain the term “quantum yield” and “quenching”
• Describe the various units of a spectrofluorimeter e.g. light source, photo-multiplier, recorder and its operation.
• Describe the methods of preparation of a sample for analysis by spectrofluorimetry.
• Explain the applications of fluorimetry and its limitation in analytical work.

❖ PSE 233: Process Safety and Environmental Quality

➢ Process Safety and Environmental Quality: 4 credits (60 hours); L, T, P, SPW

1. Introduction and Importance of Safety
   • Introduction.
   • Importance in institute shop
   • Importance in industry.
   • Accident cost.
2. Accidents in Petroleum and Chemical Industry
   • Accident in Petroleum Industry.
   • Accident in mines.
   • Accident in power Plants.
   • Accident in paint shop/ Industry.
   • Explosive vapors and gases.
   • Accident in fertilizers and others chemical Industries.
   • Toxic materials and chemicals.
3. Accidents in Mechanical Industry
   • Material handling and transportation.
   • Accidents due to hand tools
   • Accidents in machine shop.
   • Accidents in metal work shop.
   • Accidents in wood working shop.
   • Accidents in foundry, welding & forging shop.
   • Industrial ventilation.
   • Exhaust systems.
- Industrial noise.
- Illumination for safety and comfort.
- Industrial hygiene and plant sanitation.

5. Personal Protective Equipment's
   - For face and hand protection.
   - For body protection.
   - For protection from chemical & gases.

6. Safety on Plant
   - Plant layout for safety.
   - Housekeeping for safety.
   - Layout for safety.
   - Safety colors and signs.

7. Fire Accidents
   - Fire hazard.
   - Causes.
   - Chemical fires.
   - Fire fighting Equipment's.
   - Plant layout for fire safety.

8. First Aid
   - Importance.
   - Procedure.
   - Extended medical services.

9. Promoting Safety
   - Employees training.
   - Displays.
   - Guidance.

10. Safety Laws
    - Pakistan Factory Act (laws concerning to safety).
    - Workman Compensation Act.
    - Industrial Insurance.

❖ PSE 234: Reservoir Engineering

➢ Reservoir Engineering: 5 credits (75 hours); L, P, SPW

Definitions and Fundamental principles

1. Gas properties:
   - Ideal Gas Law
   - Properties of Natural Gases
   - Calculation of Pseudocritical Gas Properties
   - Correlations for z-factor
   - Gas FVF
   - Gas Density
   - Gas Compressibility
   - Gas Viscosity

2. Oil properties:
- Oil Formation Volume Factor
- Bubble Pressure and Solution GOR
- Oil Compressibility
- Oil Viscosity

3. **Water properties:**
   - Water Formation Volume Factor
   - Solution Gas/Water Ratio
   - Water Compressibility
   - Water Viscosity
   - PVT Diagram

4. **Material balance in oil reservoirs**
   - Reservoir drive mechanisms, oil recovery
   - General material balance equation (MBE)
   - Special cases of MBE, volumetric model
   - Gravity drainage
   - Reserves

5. **Primary recovery methods:**
   - Rock and fluid expansion
   - Solution gas drive
   - Gas cap drive
   - Water drive
   - Gravity drainage
   - Combination drive

6. **Secondary recovery methods:**
   - Water flooding (cold water injection)
   - Injection of immiscible gases

7. **Reserves and the Methods of Estimation:**
   - Analogy
   - Volumetric
   - Decline analysis
   - Material balance calculations for oil reservoirs
   - Material balance calculations for gas reservoirs
   - Reservoir simulation

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**PSE 235: Petroleum Production Technology**

- Petroleum Production Technology: 4 credits (60 hours); L, P, SPW

1. **Introduction**
   - Organization of petroleum Production Company.
   - Production Systems.

2. **Well completions and perforations.**
   - Introduction to well completion.
   - Methods of production well completion.
   - Completion equipment’s
3. **Work over and well services.**
   - Production completion procedures
   - Perforation well.

4. **Wire line**
   - Introduction
   - Surface Equipment’s
   - Down Hole service Tools
   - Sub surface well equipment’s.

5. **Oil field surface Production equipment’s**
   - Well Head
   - Surface Gathering system.
   - Production separator
   - Test Separators

6. **Oil field surface processors**
   - Crude oil desalting
   - Crude oil dewatering
   - Crude oil storage.
   - Produced water treatment.
   - Pipeline scraper launcher/receiver

7. **Well Stimulation**
   - Information
   - Stimulation methods.
   - Selecting stimulating candidates.
   - Benefits and limitations of well stimulation.

8. **Artificial Lift Methods**
   - Introduction.
   - Sucker rod pumping.
   - Gas lifting.
   - Subsurface electrical pumping.
   - Subsurface hydraulic pumping.
   - Selection of artificial lift methods.

9. **Oil Production Safety**
   - Introduction.
   - Flammability limits of hydrocarbons.
   - Preparation limits of hydrocarbons for maintenance.
   - Safety factors in process equipment.
   - Electricity.
1. **Introduction to Well Logging & Well Testing**
   - Well Logging in Oilfields
   - Well logging in Gas Fields
   - Introduction to well testing
   - Well testing of oilfields
   - Well testing of gas fields

2. **Well logging Techniques**
   - Types of well logs.
   - Driller's logs.
   - Sample logs.
   - Mud logs.
   - Electric logs.
   - Radioactivity logs.
   - Conventional Resistivity Log
   - Density Log
   - Neutron Log
   - Formation Log
   - Production Log „PLT
   - Induction Log
   - Temperature Log
   - Sonic Log
   - Nuclear Magnetism Log

3. **Oil Well Testing**
   - Purposes of well testing.
   - Types of well tests.
   - Potential test of oil wells.
   - Productivity Index.
   - Specific Productivity Index.
   - Stock Tank Measurement.
   - Portable well testers.
   - Batch Type Meters.
   - PD Meters.
   - Gas Oil Ratio (GOR).
   - Drill Stem Test (DST).
   - Problems.

4. **Gas Well Testing**
   - Introduction.
   - Types of gas well testing
   - Point-Tube gauging of low-pressure wells.
   - Back-pressure testing.
   - Determination of Absolute Open Flow Potential (AOFP).
   - Multiple test.
- Isochronal test.
- Specific gravity of flowing fluids.
- Causes of deterioration in performance of gas wells.
- Problems.

**PSE 237: Accounting and labor law**

- **Accounting:** 2 credits (30 hours); L, T, SPW
  1. Generality on analytical accounting and business management
     - Objective;
     - Role;
     - Concept of burden.
  2. Analysis of expenses
     - Liable burdens;
     - Direct and indirect expenses;
     - Valorisation of stocks.
  3. Method of full costs
     - Cost of purchase;
     - Cost of production;
     - Cost of returns;
     - Calculation of the results.

- **Labor law:** 1 credit (15 hours); L, T, SPW
  
  **A- First Part**
  1. The concept of law
  2. The characters of the rule of law
  3. The sources of law (the hierarchical standards)
  4. The application of the Act (the non-retroactivity of the Act and the territoriality of the law)
  5. The judicial institutions (courts, a principle of a double degree of jurisdiction, appeal in cassation)
  6. Sanctions for violation of the rule of law (inhibition, execution, repair, repression)

  **B- Second Part**
  1. The sources of labor law
  2. The different labor contracts (conventional contracts and precarious contracts)
  3. Execution of the work contract (payment of salary and claim of salary, different professional sanctions)
  4. Dismissal and resignation
  5. Resolution of disputes in respect of work
PSE241: Industrial Safety and Safety Culture

- Industrial Safety and Safety Culture: 4 credits (60 hours); L, T, SPW

**General objective:**
Understand the importance of safety in industry, Know the causes and ways of preventing industrial accidents not caused by Fire, Appreciate what is involved in safety inspection, Appreciate the various causes and fire prevention in industry, Know the various methods and proceedings in firefighting, Appreciate the factories act and the principals involved in factory law.

**Contents:**
importance of safety in industry, causes and ways of preventing industrial accidents not caused by Fire, involvement of safety inspection, causes and fire prevention in industry, methods and proceedings in firefighting, factories act and the principals involved in factory law.

PSE 242: Organic Chemistry

- Organic Chemistry: 5 credits (75 hours); L, T, P, SPW

1. **The application of spectrophotometric techniques in the identification of organic compound**
   - List the frequency range of UV radiation.
   - Explain the effect of the interaction of UV light with organic compounds.
   - Explain electronic transitions in terms of molecular orbital theory (p-p* and n-p*)
   - State wavelength in S.I. units and intensity of band as (E)
   - Explain that the wavelength of maximum absorption is called $\lambda_{\text{max}}$ and the intensity of absorption at $\lambda_{\text{max}}$ is $E_{\text{max}}$.
   - Give and be able to use the Beer-Lambert law relating absorbance to concentration.
   - Explain the use of UV spectrum in identification of unsaturated linkages, chromophores and aromatic systems.
   - Explain how the interaction of infra-red radiation with organic molecules gives rise to stretching, bending, vibration and wagging of the molecules.
   - Assign absorption frequencies to the following functional groups:
     - OH: -OR; -NH2; -X-C; HC=0; C=O; alkenes; alkynes and nitriles.
   - Explain how the “finger print” region between 1450 - 650 L-1 is unique for any compound.
   - Explain how the substituent groups attached to a functional group affects the absorption frequency of the functional group.
   - Interpret the spectrum of a known compound.
   - Explain the theory of NMR.
1. Explain the term chemical shift with particular attention to chemical shift values for H1.
2. Understand that chemical shift is affected by the electronic environment of the nucleus - deshielding and shielding effects.
3. Identify chemical shifts for different types of protons
4. Understand and be able to predict equivalence of hydrogen atoms in a molecule.
5. State the scales adopted for H1 nmr spectrum.

2. The chemistry of monosubstituted aromatic compounds
   - State the general formulae for monosubstituted aromatic compounds.
   - Describe the physical and chemical properties of monosubstituted aromatic compounds.
   - State IUPAC names for monosubstituted aromatic compounds.
   - Know how to prepare monosubstituted aromatic compounds (by halogenation, nitration, sulphonation, alkylation, acylation) from non-substituted aromatic compounds
   - Compare reactions of monosubstituted aromatic compounds with non-aromatic compounds
   - List uses of monosubstituted aromatic compounds.

3. The principles of organic reaction mechanism applied to aromatic system.
   - Describe the following types of reactions, encountered in organic chemistry - addition, elimination, substitution and re-arrangement reactions
   - Explain the following:
     - Inductive, Mesomeric and Electromeric effects
     - Identify ortho, para and meta positions on a monosubstituted aromatic compound.
     - List examples of ortho-para directing and meta directing groups.
     - Explain the term electrophiles and nucleophiles.
     - Describe the mechanism of electrophilic aromatic substitution and nucleophilic aromatic substitution. electrophilic substitution with respect to the following:
       - Halogenation of benzene;
       - Nitration of benzene;
       - Sulphonation of benzene
       - Friedel craft reactions.
   - Draw diagrams of Energy against reaction co-ordinate for the above reactions and relate the shape of the Energy curves to the mechanism of the reaction
   - List the differences between electrophilic aromatic substitution and nucleophilic aromatic substitution.
   - List other reactions of aromatic hydrocarbons like addition and oxidation reactions.
   - Describe SN1 and intermediate complex mechanism to aromatic nucleophilic substitution.
Know selected reactions of arenes: (oxidation of alkyl side chains, reduction of benzylic alcohols and ketones, chlorination of toluene)

Know selected reactions of aromatic substituents (reduction of the nitro group, oxidation of amino)

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**PSE 243: Separation Technics and Refining**

- **Separation Technics and Refining:** 4 credits (60h); L, T, P, SPW

1. **Introduction**
   - Importance of refining in petroleum industry.
   - History and development of refining.
   - Production of crude oil in Pakistan.
   - Leading crude oil producing countries of the world.
   - Classification of petroleum.
   - Types of refinery
   - Lube refinery.
   - Fuel refinery.

2. **Crude Oil Processing Units and Processing Principles.**
   - Crude tower and its strippers, splitter tower etc.
   - S.R. Gasoline stabilizer
   - High Speed Diesel.
   - High Diesel Oil.
   - Heavy Diesel Oil.

3. **Processes; Distillation, Absorption, Adsorption, Filtration.**
   - Function of distillation.
   - Equipment used in distillation furnaces.
   - Fractionating tower.
   - Atmospheric tower.
   - Vacuum tower.
   - Crude oil refining, desalting.
   - Types of distillation processes.
   - Atmospheric distillation process.
   - Different fractions.

4. **Tower Operating Condition**
   - Tower Pressure top temperature
   - Temperature gradient.
   - Control of tower operation.
   - Pressure Control.
   - Temperature Control
   - Flow Control
   - Level Control
   - Over loading

5. **Lubricating Oil Processes**
   - Lubricating Oil Processing Vacuum
   - Propane de asphalting, furfural extraction.
• Methyl Ethyl Ketone Dewaxing.
• Blending of lube oil.
• Desulfurization process.
• Plat forming process.
• Benzene Toluene Xylene extraction process

6. **Corrosion Problems in Refinery**
   • Corrosion.
   • Sulfide corrosion.
   • Acid corrosion
   • Low temperature Services
   • Non-sparking metals.
   • Neutralization chemical

7. **Reforming Processes**
   • Cracking Process & its types
     – Polymerization
     – Alkylation.
     – Hydrogenation
     – Hydrocracking
     – Isomerization
     – Esterification and hydration
   • Platforming process.

8. **Gasoline**
   • Additives of natural gasoline.
   • Alkyation process for high octane gasoline.
   • Hydrogen processing of petroleum.
   • Hydrodesulfurization.

9. **Refinery Products**
   • Volatile products, liquefied gases, natural gasoline.
   • Light oils; rocket and jet fuels
   • Motor, Engine, Machine, Spindle, and Gear Oils.
   • Greases and waxes: paraffin wax, petrolatum.
   • Residue: fuel oil, coke, asphalts carbon black.
   • Specialties: medical products.
   • Chemical: insecticides.

10. **Quality Control**
    • Quality control of crude oil.
    • Quality control of intermediate products.
    • Quality control of end products.
    • Test for Petroleum
    • Cloud and Pour point, Color.
    • ASTM Distillation.
    • Dropping point of lubricating grease.
    • Corrosiveness of petroleum products.
    • Sulfur tests.
    • Test for bituminous and semisolid materials.
    • Electric strength of transformer oil, Diesel Index
PSE 244: Instrumentation and Control

- Instrumentation and Control: 4 credits (60 hours); L; T; P; SPW

PSE 245: Transfert of Material and Units Operations

- Transfert of Material and Units Operations: 4 credits (60 hours); L, T, P, SPW

PSE 246: Professional internship

- Professional internship: 6 credits (90 hours); P
  1. Arrival and integration in the enterprise
  2. Working in an enterprise
  3. Holding of the Internship journal
  4. Choice of the topic of work in collaboration with the professional trainer and the academic supervisor
  5. Elaboration of the research outline
  6. Resources to exploit
  7. Organization of work
  8. Drafting of the report
  9. Presentation of the report before a jury

PSE 247: Economics

- Economics: 3 credits (45 hours); L, T, SPW
  1. Basic Concept of Economics
     - Definition Adam smith, Alfred Marshall, Prof, Robins
     - Natural and Scope.
     - Importance for technicians.
  2. Basic Concept of Economics
     - Utility.
     - Income.
     - Wealth.
     - Saving.
     - Investment.
     - Value.
  3. Demand and Supply
     - Definition.
     - Law of Demand.
     - Definition of Supply.
     - Law of Supply.
4. **Factors of Production**
   - Land.
   - Labor.
   - Capital.
   - Organization.

5. **Business Organization**
   - Sole Proprietorship.
   - Partnership.
   - Joint Stock company

6. **Entrepreneurial Skills**
   - Preparing, planning, establishing, managing, operating, and evaluating relevant resources in small business.
   - Business opportunities, goal setting.
   - Organizing, evaluating, and analyzing opportunity and risk tasks.

7. **Scale of Production**
   - Meaning and its determination.
   - Large scale production.
   - Small scale production.

8. **Economic Systems**
   - Free economic system.
   - Centrally planned economy.
   - Mixed economic system.

9. **Money**
   - Barter system and its inconveniences.
   - Definition of money and its functions.

10. **Bank**
    - Definition.
    - Functions of a commercial bank.
    - Central bank and its functions.

11. **Cheque**
    - Definition.
    - Characteristics and kinds of cheques.
    - Dishonor of cheque.

12. **Financial Institutions**
    - IMF.
    - IDBP.
    - PIDC.

13. **Trade Union**
    - Introduction and brief history.
    - Objectives, merits, and demerits.
    - Problems of industrial labour.

14. **International Trade**
    - Introduction.
    - Advantages and disadvantages.

15. **Management**
16. Advertisement
   - The concept, benefits, and drawbacks.
   - Principal media used in business world.

17. Economy of Cameroon
   - Introduction.
   - Economic problems and remedies
Field: PETROLEUM AND MINING ENGINEERING

Specialty: PETROLEUM LOGISTICS
1. The objective of the training

The petroleum industry is one of the most influential players in the world economy. Given the large scale of capital investment required for most petroleum projects, it is important that investment decisions are based on a thorough analysis of variables and uncertainties. An ability to assess the viability of investments and the real value of oil and gas assets is critical to success where a range of complex technologies and facilities are required. This 2 years education course enables students to:

2. Research Skills

→ General skills
  - Work independently or collaborate in a team;
  - Analyze and synthesize professional document (French, English);
  - Communicate orally, in writing, in company or outside (French, English);
  - Participate in a project petroleum logistics;

→ Specific skills
  - Gain a thorough, practical introduction to the techniques used within the petroleum industry to value projects, assets and companies
  - Practice your own valuations or critically review those produced by others
  - Develop your knowledge of general discounted cash flow principles
  - Analyse the more sophisticated simulation and real options approaches
  - Address the issues specific to the oil and gas industry such as fiscal systems, risk analysis and competitive bidding
  - Understand how to answer questions such as “How will it work?”, “What is the cost?” and “What is the return/profit?”
  - Understand the mechanics behind the distribution of petroleum resources and the organisations that constitute the industry
  - Explore the dynamics of the extraction process and the technologies used to process, store, transport and refine oil and gas
  - Analyse the processes of selling, trading and marketing gas and petroleum products
  - Evaluate the environmental and geopolitical risks and opportunities, and assess the industry’s future
3. Career opportunities

- The sectors that use or put in the value of the soil and the subsoil (mines and quarries, search for oil);
- In geotechnical engineering (geotechnical studies and recognition of sites prior to the construction of works or the opening of the field);
- In hydrogeology (their interventions will help to manage and operate a undergroundwater or a course of water).
4. Organization of teachings

- FIRST SEMESTER

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5. Courses content

❖ PLO 111: Mathematics

- **Mathematics: 4 credits (60 hours); L, T, SPW**
  1. Quadratic Equations
  2. Arithmetic Progression and Series
  3. Geometric Progression and Series
  4. Binomial Theorem
  5. Partial Fraction
  6. Fundamentals of Trigonometry
  7. Trigonometric Functions and Ratios
  8. General Identities
  9. Solution of Triangles
  10. Mensuration of Solids
  11. Vectors
  12. Matrices and Determinants

❖ PLO 112: Physics

- **Physics: 5 credits (75 hours); L, T, P, SPW**
  1. **Measurements**
     - Fundamental units and derived units.
     - Systems of measurement and S.I Units.
     - Concept of dimensions, dimensional formula.
     - Conversion from one system to another.
     - Significant Figures.
  2. **Scalars and Vectors**
     - Revision of head to tail rule.
     - Laws of parallelogram, triangle, and polygon of forces.
     - Resolution of a vector.
     - Addition of vectors by rectangular components.
     - Multiplication of two vectors, dot product and cross product.
  3. **Motion**
     - Review of laws and equations of motion.
     - Law of conservation of momentum.
     - Angular motion.
     - Relation between linear and angular motion.
     - Centripetal acceleration and force.
     - Equations of angular motion.
  4. **Torque, Equilibrium, and Rotational Inertia**
     - Torque.
     - Center of gravity and center of mass.
- Equilibrium and its conditions.
- Torque and angular acceleration.
- Rotational inertia.

5. **Wave Motion.**
   - Review Hook's law of elasticity.
   - Motion under an elastic restoring force.
   - Characteristics of simple harmonic motion.
   - S.H.M and circular motion.
   - Simple pendulum.
   - Wave form of S.H.M.
   - Resonance.
   - Transverse vibration of a stretched string.

6. **Sound**
   - Longitudinal Waves.
   - Intensity, loudness, pitch, and quality of sound.
   - Units of intensity of level and frequency response of ear.
   - Interference of sound waves, silence zones, beats.
   - Acoustics.
   - Doppler Effect.

7. **Light**
   - Review law of reflection and refraction
   - Image formation by mirrors and lenses.
   - Optical instruments.
   - Wave theory of light.
   - Interface, diffraction, polarization of light waves.
   - Applications of polarization in sun glasses, optical activity and stress analysis.

8. **Optical Fiber**
   - Optical communication and problems.
   - Review total internal reflection and critical angle.
   - Structure of optical fiber.
   - Fiber material and manufacture.
   - Optical fiber – Uses.

9. **Lasers**
   - Corpuscular theory of light.
   - Emission and absorption of light.
   - Stimulated absorption and absorption of light.
   - Laser principle.
   - Structure and working of lasers.
   - Types of lasers with brief description.
   - Applications, basic concepts.
   - Material processing.
   - Laser welding.
   - Laser assisted machining.
- Micro matching.
- Drilling, scribing and making.
- Printing.
- Laser in medicines.

10. **Heat**
- Review of calorimeter and gas laws.
- Thermal expansion of solids, liquid, and gases.
- Heat of fusion, vaporization.
- Humidity, absolute and relative.
- Law of cooling.
- Thermoelectricity.
- Thermocouple.

11. **Thermodynamics**
- Heat energy and internal energy.
- First law of thermodynamics.
- Isometric and adiabatic processes.
- Efficiency of heat engine.
- Second law of thermodynamics (both statements).
- Heat engine and refrigerator.

12. **Transfer of Heat**
- Review modes of transfer of heat.
- Emission and absorption of heat.
- Black Body Radiation.
- Laws of energy distribution.
- Planks Quantum Theory.
- The photoelectric effect.
- X-rays, production, properties, and uses.

13. **Electromagnetic Waves**
- Magnetic field around a current carrying conductor.
- Electric field induced around a changing magnetic flux.
- Moving fields.
- Types of electromagnetic waves.
- Generation of radio waves.
- Spectrum of electromagnetic waves.

14. **Atomic Nucleus**
- Structure of the nucleus.
- Radioactivity.
- Radioactive series.
- Transmutation of elements.
- The fission reaction.
- The fusion reaction.
- The nuclear reactor.

15. **Nuclear Radiations.**
- Properties and interaction with matter.
- Radiation detectors.
- Radiation damage and its effects.
- Radiation therapy
- Radioactive tracers.
- Application of radiation techniques in archeology, agriculture, chemical industry, polymerization, sterilization, food preservation, gauging and control, radioactivity.

16. Artificial Satellite
- Review law of gravitation.
- Escape Velocity.
- Orbital Velocity.
- Geosynchronous and geostationary satellites.
- Use of satellites in data communication.

17. Magnetic Materials
- Magnetism.
- Domains theory
- Para, Dia, and Ferromagnetism and magnetic materials.
- B.H. Curve and hysteresis loop.

18. Semiconductor Materials
- Crystalline structure of solids.
- Conductors, semiconductors, insulators.
- P-type and N-type materials.
- P-N junction.
- P-N junction as a diode.
- Photovoltaic cell (solar cell).

❖ PLO 113 : Introduction to Logistics & Supply Chain Management

➢ Introduction to Logistics & Supply Chain Management: 5 credits (75 hours); L, T, SPW

Synopsis:
It is difficult to visualize any product that can reach a customer without logistical support. Yet it is only in recent years that organisations have started focusing on logistics and supply chain management as a source of competitive advantage. There is a realisation that no company can do any better than its logistics system. This course provides students with an insight and understanding of the supply chain from the managerial viewpoint. It will explore state-of-the-art strategies, models and practical tools for integrating the supply chain in ways that reduce system-wide costs and improve system-wide service.

Students will learn how logistical decisions impact the performance of the organisation as well as the entire supply chain.
Topics:
1. Introduction to Supply Chain Management
2. Supply Chain Drivers and Metrics
3. Distribution Network in a Supply Chain
4. Transport in a Supply Chain
5. Network Design in the Supply Chain
6. Designing Global Supply Chain Networks
7. Demand Forecasting in a Supply Chain
8. Aggregate Planning in a Supply Chain
10. Sourcing Decisions in a Supply Chain
11. Information Technology in a Supply Chain
12. Pricing and Revenue Management in a Supply Chain
13. Coordination in a Supply Chain
14. Benchmarking with the Supply Chain Operations Reference Model

❖ PLO 114: Introduction to oil & Gas Industry

❖ Introduction to oil & Gas Industry: 4 credits (60 hours): L, P, SPW

1. Oil and Gas Industry Background
2. Oil and Gas Reserves
3. Oil and Gas in the Global Economy
4. Oil and gas supply
5. Industry financial performance
6. The role of OPEC
7. The resource curses
8. The Players
9. IOCs
10. NOCs
11. The strategic goals of IOCS and NOCs
12. Independents
13. Other firms
14. The Oil and Gas Industry Value Chain
15. Upstream: Exploration, development, and production
16. Reservoir management
17. Upstream profitability
18. Midstream: Trading and Transportation
19. Downstream: Oil Refining and Marketing
20. Gasoline retailing
21. Natural gas
22. Petrochemicals
23. Fundamentals of Business:
24. Evolution of the Industry
25. Innovation and technology
26. Mergers and acquisitions
27. Industry substitutes and alternative fuels

❖ PLO 115 : Petroleum Exploration

➢ Petroleum Exploration: 5 credits (75 hours); L, T, P, SPW

1. Understand the contribution of geological surveys to petroleum prospecting
2. Understand how geochemistry is applied to petroleum prospecting
3. Understand the geophysical techniques used in petroleum exploration
4. Gain introductory knowledge in petroleum production

❖ PLO 116: Introduction to Petroleum Geology

➢ Introduction to Petroleum Geology: 4 credits (60 hours); L, P, SPW

1. The nature of the earth’s crust
   - Use an appropriate diagram to describe the earth’s crust
   - Describe the characteristics of the inner and outer cores, mantle, oceanic and continental crusts of the earth
   - Examine the types of rocks that make up the earth’s crust
     - Igneous rocks (plutonic and volcanic)
     - Sedimentary rocks (clastic sedimentary rocks, organic sedimentary rocks, chemical or crystalline sedimentary rocks)
     - Examine the process of cementation and compaction of unconsolidated sediments
     - Examine the parts of a clastic sedimentary rock as viewed under a microscope (sediment grains, natural cement, pores)
   - Metamorphic rocks (foliated and non-foliated)
   - Examine types of minerals that make up rocks (e.g. calcite, halite, quartz, gypsum, pyrite, galena)

2. The nature of porosity and permeability of sedimentary rocks
   - Explain what is meant by porosity of a sedimentary rock
   - Examine the relevance of a rock’s porosity to the accumulation of petroleum
   - Differentiate between well sorted sand grains and poorly sorted sand grains
   - Compare the porosity of sedimentary rocks such as clay, shale, mud, limestone, dolomite etc.
   - Explain what is meant by the permeability of a sedimentary rock
• Evaluate the relevance of permeability of a sedimentary rock to the migration of petroleum
• Examine how the arrangement of rock particles such as well sorted and poorly sorted influences permeability

3. The deformation of sedimentary rocks
• Explain the cause of distortion(s) in the earth’s structure
• Describe the characteristics of monoclines, anticlines, synclines and domes
• Explain why anticlines and domes are of greater interest to petroleum prospectors
• Examine the phenomenon of faulting and describe the various types of faults:
  – Normal faults
  – Reverse faults (thrust faults)
  – Strike-slip faults
• Explain why faults are of interest to petroleum prospectors
• Describe how an unconformity is formed
• Examine an angular unconformity and a disconformity
• Explain why unconformities are of interest to petroleum prospectors
• Give an account on the evolution of a sedimentary basins

4. Understand the phenomenon of plate tectonics
• Explain the meaning of plate tectonics
• Describe the reshaping of the earth’s continents from the movement of a single landmass (pangea) to the creation of today’s continents (Permian, Triassic, Jurassic, Cretaceous, Present day)
• Give an account on the seafloor spreading theory

5. Understand the geologic of timescale and important events in the earth’s history
• Explain the meaning of geological timescale
• Analyse the geological timescale:
  – Phanerozoic (Paleozoic, Mesozoic, Cenozoic)
  – Proterozoic
  – Archean
• Discuss the 2 methods used for dating the formation of rocks and events
  – Absolute age dating (radioactive age dating)
  – Relative age dating
• Examine the importance of fossils to relative age dating
• Describe guide or index fossils, fossil assemblage and microfossils (foraminifera, radiolaria, coccoliths and diatoms)

6. The petroleum systems processes
• Examine the conditions necessary for the accumulation of petroleum (presence of a source rock, reservoir rock, trap, overburden rock)
- Explain what is meant by a kerogen and examine the types (Type 1, 2, 3 and 4)
- Examine the following stages of petroleum maturation:
  - Diagenesis
  - Catagenesis
  - Metagenesis
- Examine the essential features that a reservoir must possess for it to be effective
- Describe the characteristics of carbonate and sandstone (or clastic) reservoirs
- Give an account on primary and secondary migration of petroleum
- Give an account on how petroleum traps are formed
- Describe structural, stratigraphic, combination and hydrodynamic traps

7. **The nature and properties of petroleum**
   - Examine the chemical composition by weight of a typical crude oil and natural gas
   - Examine the types of hydrocarbon molecules that occur in crude oil and natural gas
   - Examine how different crude oils are compared using their APIo
   - Examine the various benchmark crude oils
   - Explain what is meant by the pour point, cloud point and viscosity of crude oil
   - Analyse the typical natural gas hydrocarbon composition
   - Examine the impurities that can be present in both crude oil and natural gas

8. **The oil and gas value chain**
   - Explain the meaning of the oil and gas value chain
   - Describe the upstream, midstream and downstream parts of the value chain

9. **The origins of hydrocarbons**
   - Evaluate the two contemporary theories that deal with the origin of hydrocarbons:
     - Biogenic
     - Abiogenic

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**PLO 117: Bilingual training**

- **English**: 1.5 credits (22 hours 30mn); L, T, SPW
  1. **Vocabulary**
     - Technical and usual vocabulary of the specialty
  2. **Grammar**
  3. **Bilingual expression**
     - Understanding in interaction in Technical Discussions
Continuous oral communication: Show, explain, develop, summarize, account, comment; Interactions oral communication.

4. Autonomous reading of "writings" of all levels
   - Lead by a quick reading to understand the general sense;
   - Browse a text long enough to locate desired information;
   - Gather information from different parts of the document or of the different documents in order to accomplish a specific task.

5. Write clear, detailed texts
   - Essay writing;
   - Application for employment;
   - C.V;
   - Letter of motivation;
   - Letter/memo writing and minutes of a meeting

➢ French : 1.5 credits (22 hours 30mn)); L, T, SPW

1. Vocabulaire
   - Vocabulaire du matériel de technologie agro-alimentaire
   - Vocabulaire des produits agro-alimentaires
   - Vocabulaire des activités agro-alimentaires
   - Vocabulaire des actants
   - Vocabulaire des affaires

2. Grammaire
   - Du verbe : Conjugaison aux temps communément utilisés – présent, passé composé, imparfait, futur, conditionnel, plus-que-parfait, l’impératif, l’infinitif, la voix passive ;
   - De l’adjectif : qualificatif, possessif, démonstratif, interrogatif, numéraux, indéfinis ;
   - Du nom et son article: masculin/féminin ; singulier/pluriel ; dénombrable et non-dénombrable ;
   - Du pronom : personnel, possessif, interrogatif, démonstratif, relatif, indéfini ;
   - De l’adverbe et de la locution adverbiale : pour dire comment, où, quand et pourquoi ;
   - Des fonctions grammaticales.

3. Expression et communication
   - Compréhension et interaction au cours d’une discussion technique ;
   - Communication orale courante ;
   - Communication orale interactive ;
   - De la phrase : simple, complexe, composée : interrogative, déclarative, exclamative et impérative.
   - Lecture rapide et compréhension de texte ;
   - Synthèse de texte
- De la communication : rédaction de texte, d'instructions, de rapport, d'une correspondance, d'une lettre recommandation ou de motivation, d'une demande d'emploi, d'une demande d'explication, d'une réponse à une demande d'explication, d'un CV ;
- Gestion d'une table ronde/discussion : la prise de notes, la prise de parole
- Expressions figées

❖ PLO 121 : Research Methods

➢ Research Methods: 4 credits (60hours); L, T, SPW
The Project Report aims to:
 - Improve candidate’s critical analysis skills
 - Help students apply the knowledge gained during studying the programme
 - Help apply experience in developing solutions for the project
Students should be able to:
1. Apply analytical skill in recognizing and specifying objectives and critically appraising information given, so as to arrive at a practical and reasonable evaluation of the issues.
2. Employ creativity, together with the ability to apply knowledge and experience, to develop a number of workable solutions, which need to meet economic, social and technical demands.
3. Use judgment to select the best solution in the circumstances and support this choice by local argument using the appropriate facts and figures.
4. Understand the subject areas covered in the syllabus and in particular the interrelationships of those subject areas.
5. Communicate ideas in the most effective manner using diagrams and charts, as well as the written word

❖ PLO 122 : Computer for Business I and Computer programming

Objectives: at the end of this course students should achieve knowledge and practical know-how related to computer concepts and programming

➢ Computer for Business I: 3 credits (45 hours); L, T, P, SPW
1. Generalities, impact of computer on society, current notions, basic hardware, software and networking
2. Procedures in using computer systems
3. Practical approach - hands- on
4. MS word; -MS excel; -MS power point; -Ms access

➢ Computer programming: 2 credits (30 hours); L, T, P, PW
1. Generalities on Programming,
2. Delphi and Visual Basic Programming: Visual Basic concepts, Designing programs, Program Flow, Testing and Debugging, Functions, Arrays, Interacting with the user, Interacting with the system;
3. Mastering of professional Software;
4. Algorithms

활동 123: Introduction to Drilling

Introduction to Drilling: 5 credits (75 hours); L, T, P, SPW
1. understand drilling operations
2. Understand the nature of contracts and agreements used in drilling operations and petroleum production
3. Understand how drilling operations were done prior to rotary drilling
4. Understand the nature of rotary drilling
5. Understand the nature of offshore drilling
6. Understand the various problems that can be encountered during drilling and how they can be handled

활동 124: Risk Analysis & Management

Risk Analysis & Management: 4 credits (60 hours); L, T, P, SPW
1. Understand key issues in risk management
2. Understand the issue of control and governance in risk management
3. Understand how the risk management process can be controlled
4. Understand the tools and techniques used in project risk management

활동 125: Oil & Gas Operational Safety

Oil & Gas Operational Safety: 5 credits (75 hours); L,T,P, SPW
1. The safety cultures
2. Working with contractors
3. Involvement in safety
4. SMS and well site analysis
5. Hazard prevention and control
6. Education and training

활동 126: Introducing Logistics in Exploration & Production

Introducing Logistics in Exploration & Production: 4 credits (60 hours); L,T,P, SPW
1. Introducing Logistics in Exploration and Production
2. Purchasing, Inventory and Stock
3. Managing the Warehousing Function
4. Receiving Goods, O&G Materials and Asset Management
PLO 127: Computer for business II / Civic and moral education

- **Computer for Business II**: 1 credits (15 hours); L, T, P, SPW
  1. Revision on: -MS word -MS excel -MS power point -Ms access
  2. Office automation
  3. Graphics and graphing packages
  4. Internet working
  5. Information services

- **Civic and Moral Education**: 2 credits (30 hours); L, T

  **The Concepts**
  - The citizen;
  - The Nation;
  - The State;
  - Publics Property and collective’s goods;
  - The freedoms;
  - The public service;
  - Ethics;
  - Ethics, Law and reason;
  - Ethical Problem;
  - Ethics and management.
  - Civics
  - Deontology
  - Moral consciousness
  - The universal declaration of Human Rights
  - Good governance in public services
  - The importance of civics to the life of the nation
  - Functions of the state and its citizens
  - Deontology, Professional ethics and professionalism
  - Relationship between morality, law and ethics
  - Codes of ethics

PLO 231: Organisational Behaviour

- **Organisational Behaviour**: 3 credits (45 hours)
  1. Introduction
  2. Organisational Behaviour
  3. Diversity
  4. Workplace Attitudes
  5. Personality
  6. Values and Perception
  7. Motivation
  8. Employee Involvement and Rewards
9. Groups
10. Group Outcomes
11. Work Teams
12. Communication
13. Conflict
14. Negotiations
15. Organisational Change
16. Approaches to Managing Organisational Change
17. Work Stress

❖ PLO 232 Operations management and Entrepreneurship

➢ Operations management 3 credits (45 hours) L,T,SPW

1. Introduction to operations management
2. Capacity and location planning
3. Facility layout
4. Inventory management
5. Material requirement planning
6. Scheduling
7. Project management

➢ Entrepreneurship: 2 credits (30 hours): L, T, SPW

1. Concept of the entrepreneur
2. Motivations for company creation
3. Search for ideas and evaluation
4. Search for funding
5. Choice of a legal status
6. Ethical aspects of a company

❖ PLO 233: International Transport Management

➢ International Transport Management: 5 credits (75 hours): L, T, P, SPW

Synopsis:
Transport moves products from one location to another as they make their way from the point of origin to the customer. Transport is indispensable to a nation’s economy. It is an essential element of daily life, without which many activities cannot take place. Effective and efficient transport management impacts on product, information and financial flows and is critical in achieving supply chain integration and objectives. This course provides the students with an understanding of the principles, processes and techniques for the effective management of transport for freight movement. Students will gain insights into the role and importance of transport in supply chain
management and the economy. The course examines transports role in global transport planning and execution. Transport management is viewed from the perspectives of the shipper, carrier and receiver of goods. The course gives attention to key transport players and service providers, transport costing and pricing, information management and technology, and shipper and carrier strategies.

Topics:

1. Transports Role in SCM
2. Transports Role in the Economy
3. Overview of Global Transport
4. Global Freight Planning
5. Overview of Global Freight Flows
6. Global Transport Providers, Port Operators and Customs
7. Road Transport
8. 3PL and Special Service Providers
9. Transport Economics
10. Information Management and Technology
11. Shipper Strategies
12. Carrier Strategies

❖ PLO 234: International Trade Management

➢ International Trade Management: 4 credits (60 hours); L, P, SPW

1. Shipping
2. Forwarding
3. Customs regimes
4. Financial instruments
5. Insurance issues
6. Incoterms
7. Environmental issues
8. Management of surplus and waste materials
9. Inventory accuracy
10. Match of physical quantity to records
11. Accurate records of stock movements
12. Stock-checking programmes
13. Reconciliation guidelines
14. Catalogues
15. Catalogues and inventories – the difference
16. Purpose
17. Standardization
18. Accessibility to requisitioners
19. Management issues
**PLO 235: Supply chain planning**

Supply chain planning: 5 credits (75 hours); L, T, P, SPW

**PLO 236: Health Safety & Environmental safety**

Health Safety & Environmental safety: 4 credits (60h); L, T, SPW

1. Understand the need for occupational health and safety management
2. Understand the theoretical aspects of health and safety management
3. Understand practical health and safety management issues in the oil and gas industry
4. Understand the categories of hazards associated with petroleum exploration and production
5. Understand the nature of risk assessment and control
6. Understand the importance of monitoring and reviewing occupational health programmes in an organization

**PLO 237: Financial Management and Labour Law**

Financial Management: 2 credit (15 hours); L, T, SPW

1. The Financial System
2. Time Value of Money
4. Financial Management An Overview
5. Working on Capital Management
6. Financial Statement Analysis
7. Financial Planning and Forecasting
8. Capital Budgeting Project Selection Criteria
9. Capital Budgeting Cost of Capital
10. Capital Budgeting Forecasting Cash Flows
11. Fund Raising
12. Capital Structure Policy
13. Dividend Policy

Labour Law: 1 credit (15 hours); L, T

A- First part

1. The concept of Law;
2. The characters of the Law Rule;
3. Sources of Law (Hierarchical norms);
4. Enforcement (Non-retroactivity of the law and the territoriality of the law);
5. Judicial institutions (Courts of first instance, principle of double jurisdiction, appeal on points of law);
6. Sanctions of violation of the rule of law (Inhibition, execution, reparation, repression);

B. Second part

1. Sources of Labour Law
2. The different employment contracts (classic contracts and precarious contracts)
3. Execution of the employment contract (salary and salary claim, various professional sanctions)
4. Dismissal and resignation;
5. Resolution of labor disputes

❖ PLO 241 : Chemistry

➢ Chemistry: 5 credits (75 h); L, T, P, SPW

1. Fundamental Concepts of chemistry
   ▪ Chemistry in petroleum and chemical industry.
   ▪ Elements, compounds, and mixtures.
   ▪ Atom, atomic weight, molecule, valency, molecular weight.
   ▪ Symbols, formulae, and equations.
   ▪ Molecular formula, and Empirical formula.
   ▪ Physical and chemical changes.
   ▪ Physical and chemical properties.
   ▪ Acids, bases, and salts.
   ▪ Law of conservation of mass.
   ▪ Law of constant proportion.
   ▪ Law of reciprocal proportion.
   ▪ Law of multiple proportion.

2. Structure of Atom and Chemical Bonding
   ▪ Fundamental particles of atom.
   ▪ Bohrs model of atom and its defects.
   ▪ Energy levels, sub-energy levels and orbitals.
   ▪ Electronic configuration.
   ▪ Lionization potential, electronegativity, and electron affinity.
   ▪ Ionic bond with examples.
   ▪ Covalent bond (polar and non polar), Sigma and Pi bonds with examples.
   ▪ Coordinate covalent bond with examples.

3. Physical States of Matter
   ▪ Physical states of matter, explanation with the help of kinetic molecular theory.
- Properties of liquids; surface tension, viscosity, capillary action, diffusion.
- Behavior of gases, kinetic theory of gases.
- Boyle's and Charles' law, general gas equation, problems relating to these laws.
- Graham's law of diffusion, Dalton's law of partial pressures and Gay Lussac law.
- Isomorphism and polymorphism.
- Amorphous solids.

4. **Metals and Alloys**
   - Metals and non-metals
   - Important ores; properties and uses of Cu, Al, Zn, and Fe Metals.
   - Corrosion; Definition, causes and control.
   - Alloys; introduction.
   - Compositions, properties, and uses of bell metal, stainless steel, and brass.

5. **Water**
   - Sources, chemical nature, and properties of water.
   - Impurities of water.
   - Hardness of water.

6. **Solutions and Colloids**
   - Types of Solutions.
   - Concentration.
   - Solubility.
   - Colloids.

7. **Acid and Base**
   - Concept of acid and base.
   - Properties of acid and base.
   - Strength of acid and base.

8. **Halogens**
   - Introduction to halogens.
   - Preparation, properties, and uses of Chlorine.
   - Preparation, properties, and uses of HCl.

9. **Thermo chemistry**
   - Introduction.
   - Exothermic and endothermic reactions.
   - Heat of reaction.
   - Heat of formation.
   - Heat of combustion.
   - Heat of neutralization.
   - Hess's law of constant heat summation.

10. **Electrochemistry**
    - Theory of ionization.
    - Solubility product.
Electrolytes and electrolysis.
Faraday’s laws of electrolysis.
Conductivity of electrolytes.
pH of solutions and pH scale.
Measurement of pH.

11. **Organic Chemistry**
- Introduction to Organic Chemistry.
- Classification of hydrocarbons (Alkanes, Alkenes, Alkynes, Naphthene’s, Aromatics).
- Introduction to Alcohols.
- Introduction to Alkyl Halides.

❖ **PLO 242 : Managerial Economics**

➢ Managerial Economics: 5 credits (75h); L, T, P, SPW
   1. Introduction to Managerial Economics
   2. Demand and Supply Analysis
   3. Elasticity
   4. Market Equilibrium
   5. Economic Efficiency
   6. Cost of Production in the Short Run
   7. Cost of Production in the Long Run
   8. Competitive Markets and Economic Profit
   9. Perfect Competition
   10. Monopoly
   11. Strategic Thinking and Game Theory
   12. Oligopoly
   13. Externalities
   14. Asymmetric Information
   15. Incentives and Organisation
   16. Regulation

❖ **PLO 243 : Procurement/ Inventory Management**

➢ Procurement/ Inventory Management: 4 credits (60h); L, T, P, SPW

**Synopsis:**
Every organization holds stocks of materials to allow for variations and uncertainty in supply and demand. Stocks are replenished by deliveries from suppliers and reduced to meet demands from customers. Inventory management is responsible for all aspects of stock control. High stock buffer comes at a high price and organizations are continually looking for ways of reducing their inventory costs without affecting service. This course provides students with an understanding of the principles, processes and
methods for the effective management of inventory in relation to other activities in the supply chain. The course examines both the independent demand and dependent demand methods. Attention is given to the information needed to support these methods, including information from the inventory management information system, forecasts of demand and planned operations.

Topics:

1. Stocks and Inventories
2. Stocks within an Organisation
3. Economic Order Quantity
4. Models for Known Demand
5. Models for Uncertain Demand
6. Sources of Information
7. Forecasting Demand
8. Planning and Stocks
9. Material Requirements Planning

❖ PLO 244: Warehouse & Distribution Management

➢ Warehouse & Distribution Management: 4 credits (60h); L, T, P, SPW

1. Introduction to Warehousing and Material Handling
2. Warehousing Fundamentals and Distribution
3. Facility Planning
4. Material Handling Considerations
5. Warehouse Activity Profiling
6. Measuring and Benchmarking Warehouse Performance
7. Receiving and Put away
8. Material Handling Systems
9. Order Picking Operations
10. Unitising and Shipping
11. Enabling Technologies in Warehousing
12. Warehouse Management Systems (WMS)

❖ PLO245: Midstream & Downstream Petroleum Economics

➢ Midstream & Downstream Petroleum Economics: 4 credits (60h); L, P, P, SPW

1. Oil and gas transportation options and their economics
2. Pipeline and facility tariffs
3. Liquefied natural gas (LNG) shipping economics and netback calculations
4. Underground natural gas storage (UGS) economics
5. Gross product worth (GPW) of refined products and crack spreads
6. Cost and revenue components associated with refineries
7. Gross, semi-variable, and net refinery margins and net cash values
8. Petroleum product distribution logistics and economics
9. Gas to liquids (GTL) economic issues
10. Gas to power: combined cycle gas turbine (CCGT)economics
11. Retail fuel margins

❖ PLO 246: Professional internship

➢ Professional internship: 6 credits (90 hours); P

1. Arrival and integration in the enterprise
2. Working in an enterprise
3. Holding of the Internship journal
4. Choice of the topic of work in collaboration with the professional trainer and the academic supervisor
5. Elaboration of the research outline
6. Resources to exploit
7. Organization of work
8. Drafting of the report
9. Presentation of the report before a jury

❖ PLO 247: ICT for Logistics

➢ ICT for Logistics: 3 credits (45h); L, T, P, SPW

1. Managing Information Flow in Supply Chains
2. Information Systems in Supply Chains
3. Introduction to Enterprise Resource Planning
4. Business Considerations for Implementing ERP Systems
5. Customer Relationship Management
6. Supplier Relationship Management
7. Barcodes to Facilitate Supply Chain Visibility
8. Radio Frequency Identification
9. Geographic Information Systems
10. Global Positioning System
11. Electronic Data Interchange
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