الجمهورية الجزائرية الديمقراطية الشعبية
People's Democratic Republic of Algeria
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
المدرسة العليا في علوم وتكنولوجيات الإعلام الآلي والرقمنة
Higher School of Computer and Digital Science and Technology

# SECOND CYCLE TRAINING OFFER:
# IT ENGINEER

# 2021 – 2022

| Establishment | Department of |
|---|---|
| **Higher School of Computer and Digital Science and Technology** | **2nd cycle training** |

| Domain | Sector | Speciality |
|---|---|---|
| **Mathematics and Computer Science** | **Computer science** | **Cybersecurity** |

**Head of the training area team: AIT TALEB Samiha**

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Higher School of Computer and Digital Science and Technology

# عرض تكوين في الطور الثاني:
# مهندس إعلام آلي

# 2021-2022

| مؤسسة | القسم |
|---|---|
| المدرسة العليا في علوم وتكنولوجيا ا لإعلام الآلي و الرقمنة | قسم التكوين في الطور الثاني |

| الميدان | الفرع | التخصص |
|---|---|---|
| رياضيات و إعلام الآلي | الإعلام الآلي | الأمن السيبراني |

**سميحة طالب أيت :التكوين ميدان فرقة مسؤول**

# I – Identity card of the offer

## 1 - Training location

### Training location:

ESTIN – Graduate **school** in **S** ciences and **T** echnologies of **Computing** and **Digital**

**Tel:** (213) (0) 34 82 49 09 **Fax:** (213) (0) 34 82 49 16

**Department :**

second cycle

### Training manager :

**Dr** DJEBARI Nabil

**Tel:** (213) (70 78 03 04) **E-mail:** djebari@estin.dz

**Address :**
Graduate School of Computer and Digital Science and Technology, Amizour Campus, Bejaia, Algeria

### Website :

http://www.estin.dz

### Authorization references:

Executive Decree No. 20-235 of 3 Moharram 1442 corresponding to August 22, 2020.

## 2 - External partners

**Partner institutions:**

- A. Mira University of Bejaia
- ESI Algiers
- ESI Sidi Bel Abbes

**Agreements to be established with the socio-economic sector:**

- Public Administration (Local Authorities, Security Services, Civil Protection etc.)
- Bejaia Port Company
- Algeria Telecom
- Mobile network operators (Mobilis , Djezzy, Ooredoo)
- SONELGAZ
- SONATRACH
- Banks (BNA, CPA, BADR etc.)
- Judicial Administration
- General Packing
- Agro-food companies (Cevital, Laiterie Soummame, DANONE DjurdjuraAlgeria, CANDIA, etc.)
- Etc.

**International cooperation :**

- Central School of Paris, France
- Central School of Marseille , France
- National Institute of Applied Sciences (INSA ) of Lyon , France
- University of Paris East Creteil, France
- University of Lille 1 , France
- University of Brest , France
- ENSEEIHT Toulouse , France
- Compiègne UTC , France
- University College Dublin, Ireland
- University , Quebec
- RMIT, Melbourne, Australia
- University of Nantes, France
- University of Artois , France
- University of Illinois at Chicago, USA
- - Ferrand University , France
- Nancy University, France

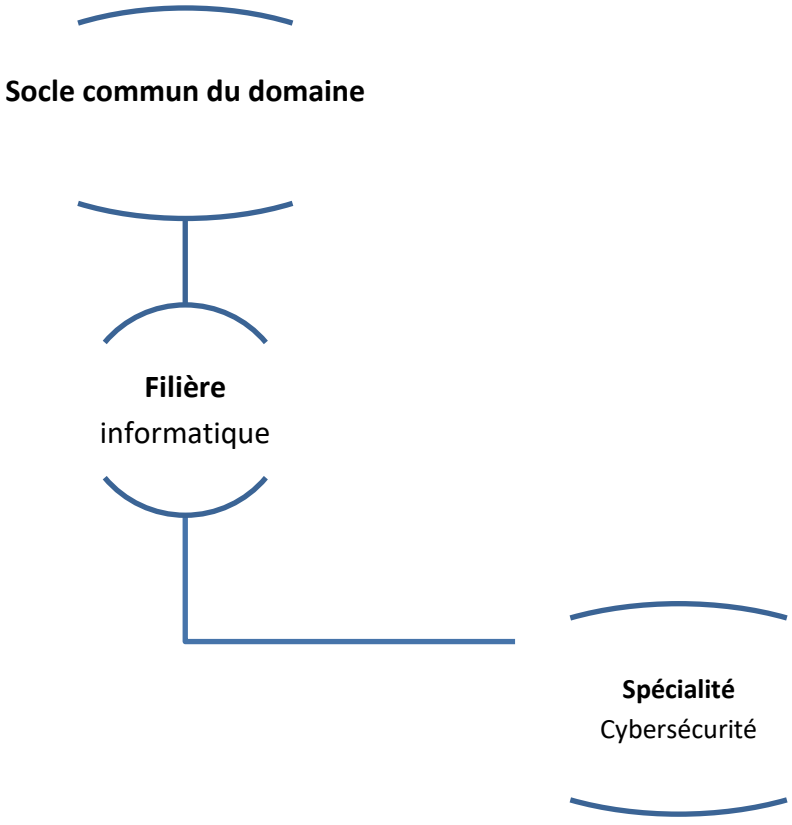
## 3 – Context and objectives of the training

### A – Position of the project

**Title of the course:**

IT ENGINEER

**Title of specialty:**
Cybersecurity




### B – Training objectives

Currently , we are witnessing a dizzying increase in Internet crime (cybercrime), economic and political espionage , attacks against various infrastructures including energy, communication, air and rail transport, etc. This context obliges us to protect ourselves against these growing threats by implementing the necessary measures and skills.

In this perspective, the Higher School of Computer and Digital Science and Technology ( ESTIN ) wishes to train engineers to solve these security problems . It is a question of training skills capable of identifying vulnerabilities, of securing computer and information systems, and essentially of implementing security and counter-attack mechanisms .

The main purpose of this cybersecurity training offer is to provide students with training based on a multidisciplinary knowledge base, in a new specialty of security and cybersecurity. It brings together computer knowledge and discusses in detail the problems related to cybercrime, as well as the appropriate solutions.

This training offer will meet the needs of the national economy for engineers capable of:

- Have a basic IT and security culture. In particular, it is about gaining a true understanding of the fact that security affects several levels: applications, operating systems, networks and hardware.
- Master concrete skills and tools that can be used in companies, which are immediately operational and competitive on the job market.
- Gradually acquire knowledge of the incremental cycle of security ( Definition of security policies, threats, protections, IT security audit ).

**C. Target profiles and skills**

***Engineering*** training in ***Cybersecurity*** addresses, in a common basic base with other training, the various aspects of sufficiently broad computer culture (Programming, Architectures, Systems, Networks, AI, Cryptography), well suited to the computer engineering professions and their evolutions future.

This training will address, through a specialized base, the functional and legal techniques and methodologies of the Security of Computer and Information Systems by providing in-depth knowledge of security audit techniques and securing infrastructures, business data and applications.

At the end of this training, graduates will have acquired basic knowledge, not only in fundamental computer science, but also in technology, security and computer networks.

The Cybersecurity graduate will be able to define, implement and manage a security policy for the company. It will therefore be able to protect companies' information systems, data and equipment in

operation. He must master the different phases of risk analysis, specification and implementation of technical security solutions to minimize threats, in prevention or in reaction.

**D – Regional and national employability potential**

Currently, there are an estimated 432 million hackers worldwide. According to Cybersecurity Ventures, the global cybersecurity market in 2020 is valued at $170 billion. Cybersecurity is becoming a key issue for companies in an environment where connections are multiplying, the risks linked to the Internet of Things are creating new potential vulnerabilities, and cybercrime and cyberwar are part of daily risks. ESTIN graduates will be able to offer their services and skills in several business sectors. This training offers certain opportunities in terms of employability throughout the national territory.

**Activity area :**

Cybersecurity training responds to the extremely strong demand for training experts in the various fields related to industry, home automation, telecommunications, transport, aeronautics, health, construction, energy, environment, defence, trade, etc.
This training offers graduates the opportunity to acquire skills that allow them to access a higher level of academic knowledge in this field, both in terms of research / development but also with a view to professional integration.

**The main functions:**

The cybersecurity graduate will perform various functions in all trades related to the network, security, mobile computing and Internet of Things sectors, whether at the level, engineering, architecture, consulting and auditing. .
He will occupy various positions such as: security engineer, architect and developer of new technology applications, research and development engineer, project manager, auditor, controller, evaluator, trainer, instructor, information systems security expert, security developer , Security Architect, Penetration Testing Expert, Ethical Hacker, Analyst, Consultant, Crisis Management Specialist, Information Systems Security Manager, etc.

**Regional and national contexts of professional integration:**

- Industrial fabric (public and private).
- Administrations, central, regional and local authorities
    - Department of Defense
    - Ministry of Interior

- Other Jurisdictions

- National and International Companies
- Universities, Grandes Ecoles, and Research Centers.

## E. General organization of the training

### The educational path:

The duration of the second cycle training leading to the Engineering degree is made up of six semesters and consists of a supervised training (1935h) and a directed training (2288h) totaling 4223 hours, or 180 credits.

| Supervised training | | | | | |
|---|---|---|---|---|---|
| **Teaching unit** | **Module number** | **Hourly volume** | **Credit** | **% in credits for each teaching unit** | **Total** |
| **Fundamental EU** | 20 | 1147:30 | 91 | 58.82% | **39** mods **1935 hrs** |
| **Methodological Unit** | 14 | 675 hours | 44 | 35.29% | |
| **EU Discovery** | 3 | 67:30 | 9 | 3.53% | |
| **Transversal UE** | 2 | 45 hours | 6 | 2.36% | |

| Hours | S1 | S2 | S3 | S4 | S5 | Total | |
|---|---|---|---|---|---|---|---|
| **Course** | 180h | 180 hours | 3:30 p.m. | 180 hours | 3:30 p.m. | 855 hours | 44.19% |
| **TD** | 3:30 p.m. | 3:30 p.m. | 1:00 p.m. | 90 hours | 67:30 | 630 hours | 32.56% |
| **TP** | 90 hours | 67:30 | 90:00 a.m. | 112:30 p.m. | 112:30 p.m. | 450 hours | 23.25% |
| **Total** | **427 h 30** | **405 hours** | **382 h 30** | **382 h 30** | **337 h 30** | **1935 hrs** | **100%** |

| Directed Training | | | |
|---|---|---|---|
| **Nature** | **Hourly volume** | | **Total** |
| **Personal work** | 1688 h | 73.78% | **2288 hours** |
| **Visit of industrial sites** | 60 hours | 2.62% | |
| **Internship** | 420 hours | 18.36% | |
| **EFP** | 100 hours | 4.37% | |
| **Conferences** | 8 p.m. | 0.87% | |

The **supervised training** is made up of 39 modules, i.e. **1935** hours.

Teaching is divided into four Teaching Units (UE) per semester. Each Teaching Unit includes Lectures (CM), Tutorials (TD) and Practical Works (TP).

**Directed training** is made up of tutored projects, internships and seminars whose objective is to place students in a situation of autonomy and application of the skills acquired during the training.

### Conditions of access and progression:

According to the regulations in force, national recruitment in the specialty is open to students from higher schools and university graduates admitted to the competition.

### Assessment methods and progression criteria:

- Half-yearly written checks
- Oral exam
- Conferences
- Evaluation of internship reports
- Assessment of personal work

**F – Performance indicators expected from the training**

All training must meet the quality requirements of today and tomorrow. As such, to better appreciate the performance expected from Cybersecurity training, a certain number of mechanisms are proposed for this course to evaluate and monitor the progress of lessons, training programs, student/teacher and student/administration relations. , the future of graduates as well as the assessments of the school's economic partners regarding the quality of the graduates recruited and/or the teaching provided.

The methods of evaluation can be concretized by surveys, follow-up of students in training and surveys of recruited students as well as with their employers.

Any study, inquiry or event will be the subject of a report which will be distributed and archived.

**Evaluation of the course of the training:**

In addition to the regular meetings of the teaching committee, a meeting at the end of each semester will be organised. It brings together teachers and student representatives from the class to discuss any problems encountered, possible improvements to be made to teaching methods in particular and to training in general.

educational committee is proposed below:

**Prior to training:**

- ✓ Rate of students having chosen this offer (Supply/demand ratio).
- ✓ Relationship between the supervision capacity and the number of students requesting this training.
- ✓ Evolution of the number of registration requests for this offer over the past years.
- ✓ Rate and quality of students who choose this offer.

**During the training:**

- Regularity of educational committee meetings and archiving of minutes.
- Inventory of recurring problems raised during these meetings and not resolved.

- Validation of End of Cycle Project proposals during a meeting of the training team.
- Appointment of a teacher/mediator/interlocutor with the students who will activate in parallel and outside the meetings of the teaching committees:

(The mediator is a teacher, having easy contact with the students and open to discussions, who will act as the interface between the students and the administration to solve critical or urgent problems that may arise between the students and a teacher).

**After training:**

- Number and success rate of students.
- Reward and encouragement of the best students.
- Number and dropout rate (failures and dropouts) of students.
- The causes of student failure are listed.
- Organization of remedial sessions for students in difficulty.
- Reorientation alternatives are offered to students in a situation of failure.
- Number and rate of students from this training who obtain their diploma within a reasonable time.
- Number, rate and quality of students from this training who continue their studies in Doctorate.
- Survey of student satisfaction with teaching and teaching methods.
- Quality of students from this training who obtain their diploma (quality criteria to be defined).

**Evaluation of the progress of programs and courses**

The lessons provided during this course will be subject to regular evaluation (half-yearly or three-yearly) by the school's training team and will then be sent, on request, to the various bodies, such as the National Pedagogical Committee of Science and Technology Schools, Regional Conferences, etc.

A system for evaluating programs and teaching methodologies is then set up based on the following indicators:

- The educational rooms are equipped with support materials for educational improvement (projection systems (data shows), wifi connection, etc.).
- Educational laboratories with the necessary equipment in line with the content of the training.
- Existence and use of the intranet at the level of teaching laboratories and computing centres.
- Existence of anti-virus software and educational software in educational laboratories and

computing centres.

- IT maintenance contracts with suppliers.
- Training of technical staff on computer resources and teaching materials.
- Existence of a digital teaching platform in which courses, TD and TP are accessible to students and their questions answered.
- End of cycle dissertations are digitized and available.
- Rate of renovation and use of teaching materials.
- Number of practicals carried out as well as the multiplication of the type of practicals per subject (diversity of practicals).
- Easy access to the library (sufficient number of places in the library, remote access to works in internal and external networks, opening hours outside teaching hours, etc.).
- Number and rate of acquisition of works by the institution's library in relation to the field of computer security and computer networks.
- Rate of use of works, available in the institution's library, in relation to the specialty.
- Adaptation of programs to industrial needs and proposals for updating.
- Involvement of professional speakers in teaching (visit of the company, course/seminar provided by professionals on an aspect of interest to the company but not covered by the training, etc.).
- Involvement of professionals in the preparation or amendment of a subject or part of a teaching subject (course, practical work) according to industrial needs.
- Opening of new Master courses in relation to the specialty in question.

**Integration of graduates:**

A coordination committee will be created, made up of those responsible for training and members of the administration, which will mainly be responsible for monitoring the integration of graduates of the specialty into professional life. In addition, this committee will be responsible for:

- Establish a file for monitoring graduates of the sector;
- Identify and/or update existing economic and industrial potential at regional and national level;

- Anticipate and encourage new professions in relation to the specialty in association with economic actors (the chamber of commerce, the various employment support agencies, the various public and private economic operators, etc.);
- Participate in any action concerning the professional integration of graduates (organization of events with socio-economic operators).

To carry out these missions, this committee will have full latitude to carry out or order any study or survey on the employment and post-employment of graduates.

Below is a list of indicators and methods that could be considered to assess and monitor this project:

**Professional integration of graduates:**

- Recruitment rate of graduates in a position directly related to training.
- Possibility of recruitment in different sectors related to AI and data sciences.
- Recruitment of graduates in sectors indirectly related to the field of security and computer networks.
- Nature of jobs held by students at the end of their studies.
- Number and rate of students graduating from this training holding positions of responsibility in companies.
- Diversity of outlets.
- Degree of adaptation of the graduate recruited in the working environment.
- Success of candidates in professional integration.
- The speed of absorption of graduates into the world of work.
- Organization of specific training for graduates to help them succeed in recruitment competitions.
- Availability of information on recruiting positions nationwide.
- Potentials implicit in this training for business creation.
- Refresher training on entrepreneurship provided.
- Creation of start-ups by graduates of the specialty.

**Interest shown by the professional in the specialty:**

- Degree of satisfaction of potential employers.
- Interest shown by employers in computer security training.
- Relevance of the specialty for the world of work.
- Survey on the evolution of trades/jobs in the field of the specialty.
- Sustainability and consolidation of relations with manufacturers, in particular following end-of-cycle internships.

- Monitoring of agreements (School/Company) and evaluation of relations between the company and the school.
- Organization of scientific events (open days, forums, workshops) with socio-economic operators concerning the professional integration of graduates.

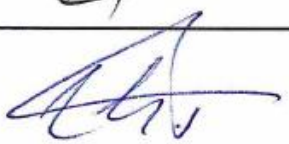
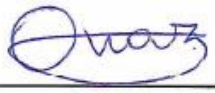
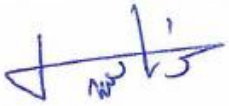
**4 – Human resources available**

**A - Supervisory capacity**

| Nom et Prénom | Grade | Domaines decompétence | Signature |
|---|---|---|---|
| TARI Abdelkamel | Pr. | Informatique, Recherche opérationnelle | |
| SEBAA Abderrazak | MCA | Informatique | |
| BELAID Ahror | Pr. | Informatique | |
| AZOUAOU Faical | Pr. | Informatique | |
| KHANOUCHE Mohamed Essaid | MCA | Informatique | |
| FARAH Zoubeyr | MCA | Informatique | |
| EL BOUHISSI Houda | MCA | Informatique | |
| Djebari Nabil | MCB | Informatique | |
| SADI Mustapha | MCB | Informatique | |

**Teaching capacity** : 100 students

**B - Internal teaching team mobilized for the specialty**

| | | | |
|---|---|---|---|
| KACIMI Farid | MAB | Informatique |  |
| CHELOUAH Leila | MAB | Informatique |  |
| CHEKLAT Lamia | MAB | Informatique |  |
| AIT TALEB Samiha | MAB | Informatique |  |
| OUAZINE Kahina | MAB | Informatique |  |
| BESSAM Amrouche | MAB | Electronique |  |
| HAMADOUCHE Taklit | MAB | Mathématique |  |
| HAMMAMOUCHE Assia | MAB | Informatique |  |
| SOUFIT Massinissa | MAB | Mathématique |  |
| KHERBACHI Hamid (Associé) | Pr. | Probabilités-Statistiques |  |
| NASRI Akila | MAA | Mathématique |  |

### C - External teaching team mobilized for the specialty

The ESTIN school plans to set up two rooms fully equipped with the latest generation equipment for distance learning. The international network that we have woven for more than two decades will support the training provided by interventions either face-to-face or remotely. Here is a non-exhaustive list of internationally recognized scientific personalities in the field

| Full name | Grade | Area of expertise | Subjects to teach |
|---|---|---|---|
| ADI Kamel (University of Quebec in Outaouais, Canada) | Prof. | Security | Formal methods for security<br>End of cycle seminar<br>Doctoral studies |
| AHMED NACER Mohamed (USTHB) | Prof. | Software engineering | Software engineering<br>Doctoral studies |
| AIT AMEUR Yamine (ENSEHIT, Toulouse, France) | Prof. | FormalMethods | Formal methods<br>End of cycle seminar<br>Doctoral studies |
| ALILI Mohamed (University of Quebec in Outaouais) | Prof. | AI, Machine Learning | AI<br>End of cycle seminar<br>Doctoral studies |
| SAIS Lakhdar (Artois University, France) | Prof. | Complexity, advanced algorithmic | Complexity of issues<br>End of cycle seminar<br>Doctoral studies |
| AMIRAT Yacine (Paris-Est University, France) | Prof. | AI, Reasoning, Fuzzy Logic | Knowledge Engineering<br>End-of-cycle seminar Doctoral training |
| KHEDDOUCI Hamamache (University of Lyon 1, France) | Prof. | Big Data, Graphs, Semantic Networks | Operational research 2<br>End-of-cycle seminar Doctoral training |
| NOURINE L'Houari (University of Clermont-Ferrand, France) | Prof. | Algorithmic complexity | End-of-cycle seminar Doctoral training |
| TARI Zahir (RMIT-Melbourne, Australia) | Prof. | Distributed Systems, Cloud Computing | Blockchains<br>End-of-cycle seminar Doctoral training |
| DJOUDI Mahieddine (University of Poitiers , France ) | Dr/HDR | Digitization of education systems | Digitization technologies in organizations<br>Doctoral studies |
| BOUABDELLAH Abdelmadjid (UTC of Compiègne, France) | Prof. | advanced networks | Networks 2<br>Doctoral studies |
| AhcèneBounceur (UBO, | Dr/HDR | Mobile networks | Cloud Security, IoT |

| | | | |
|---|---|---|---|
| France) | | | End-of-cycle seminar Doctoral training |

### D - Overall summary of human resources mobilized for the specialty

| Grade | Internal workforce | EffectiveExternal | Total |
|---|---|---|---|
| **Teachers** | 03 | 12 | **15** |
| **Lecturers (A)** | 05 | 01 | **06** |
| **Lecturers (B)** | 10 | 00 | **10** |
| **Assistant Professor (A)** | 01 | 00 | **01** |
| **Assistant Professor (B)** | 05 | 01 | **06** |
| **Technical and support staff** | 06 | 00 | **06** |
| **Total** | **30** | **14** | **44** |

**NB** : The training is accompanied by Algerian skills established abroad, some lessons will be provided jointly by these skills and those of the school.

## 5 - Material resources specific to the specialty

### A - educational laboratories and equipment

- Computing Center
- EAD room (Distance Education)
- Languages multimedia room

### B - Internship sites and in-company training

| Training place | Number of students | Training period |
|---|---|---|
| CHU Khelil AMRANE | 10 | 2 months |
| NAFTAL | 10 | 2 months |
| CEVITAL | 10 | 2 months |
| Algeria Telecom | 10 | 2 months |
| Algeria | 10 | 2 months |
| Optimum Telecom Algeria (Djezzy) | 10 | 2 months |
| Mobilis ATM | 10 | 2 months |
| SONELGAZ | 10 | 2 months |
| SONATRACH | 10 | 2 months |
| Public administration | 10 | 2 months |

### C - Documentation available at the establishment level

The school has an initial documentary fund made up of 200 books and a book acquisition operation will be launched as part of the 2021 budget year. In addition, the ESTIN school has set up a digital library by the teachers involved in the training.

ESTIN students are also allowed to access the central library of Abderrahmane MIRA University in Béjaia, pending the establishment of the school's central library.

## D - Personal and ICT workspaces available at school level

| type of logistics | Description |
|---|---|
| Educational premises | - 02 amphitheatres with a capacity of 250 seats<br>- 02 amphitheatres with a capacity of 400 seats<br>- 06 amphitheatres with a capacity of 300 seats<br>- 25 tutorial rooms with 40 places<br>- 29 practical work rooms with 20 places each<br>- 01 conference room with a capacity of 180 seats<br>- 01 Auditorium with a capacity of 500 seats |
| Laboratories/projects/training support research teams | - Laboratory of Computing and Advanced Digital Technologies (LITAN). Approval outstanding.<br>- Medical Informatics Laboratory (LIMED, UAMB-Béjaia) |
| Library | - Central reading room with a capacity of 700 seats<br>- Internet rooms |

In addition, a pooling of infrastructures is planned with the Abderrahmane MIRA University of Béjaia (an agreement will be signed for this purpose).

## II – Half-yearly organization sheets for the teaching of the specialty

**Semester 1 : 1st year of the second cycle (common semester with the Cybersecurity specialty)**

| Teaching unit | Materials | Credits | Coefficient | Weekly hourly volume | | | Semester Hourly Volume (15 weeks) | Work Staff (15 weeks) | Assessment method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entitled | | | Course | TD | TP | | | Continuous monitoring | Review |
| **Fundamental EU Code: UEF 1.1 Credits: 9 Coefficients: 5** | Operating system | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| | Networks 1 | 4 | 2 | 1h30 | 1h30 | 1h30 | 67:30 | 45:00 | 40% | 60% |
| **Fundamental EU Code: UEF 2.1 Credits: 9 Coefficients: 5** | Data base | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| | Software engineering | 4 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| **Methodological Unit Code: EMU 1.1 Credits: 9 Coefficients: 6** | Operational Research 1 | 3 | 2 | 1h30 | 1h30 | 1h30 | 45:00 | 30:00 | 40% | 60% |
| | Random Processes and Queues | 3 | 2 | 1h30 | 1h30 | | 67:30 | 30:00 | 40% | 60% |
| | Language theory | 3 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| **Transversal UE Code: UET 1.1 Credits: 3 Coefficients: 1** | Technical English 1 | 3 | 1 | 1h30 | | | 10:30 p.m. | 32:30 | | 100% |
| **Total semester 1** | | **30** | **17** | **12:00 p.m.** | **10:30 a.m.** | **6:00 am** | **427h30** | **307:30** | | |

**Semester 2: 1st year of the second cycle (common semester with the Cybersecurity specialty )**

| Teaching unit | Materials | Credits | Coefficient | Weekly hourly volume | | | Semester Hourly Volume (15 weeks) | Work Complementary in Consultation (15 weeks) | Assessment method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entitled | | | Course | TD | TP | | | Continuous monitoring | Review |
| **Fundamental EU Code: UEF 1.2 Credits: 8 Coefficients: 4** | Distributed Architecture and Intensive Computing | 4 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| | Networks 2 | 4 | 2 | 1h30 | 1h30 | 1h30 | 67:30 | 30:00 | 40% | 60% |
| **Fundamental EU Code: UEF 2.2 Credits: 10 Coefficients: 6** | Artificial intelligence | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| | IT security | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| **EU Methodology EMU Code 1.2 Credits: 9 Coefficients: 6** | Operational Research 2 | 3 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| | Formal methods | 3 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| | Numerical analysis | 3 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| **Discovery Teaching Unit Code: UED 1.2 Credits: 3 Coefficients: 1** | Entrepreneurship and digital start-ups | 3 | 1 | 1h30 | | | 10:30 p.m. | 32:30 | | 100% |
| **Total semester 2** | | **30** | **17** | **12:00 p.m.** | **10:30 a.m.** | **04:30** | **405h00** | **292h30** | | |

**Semester 3: 2nd year of the second cycle (joint semester with the Cybersecurity specialty )**

| Teaching unit | Materials | Credits | Coefficient | Weekly hourly volume | | | Semester Hourly Volume (15 weeks) | Work Complementary in Consultation (15 weeks) | Assessment method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entitled | | | Course | TD | TP | | | Continuous monitoring | Review |
| **Fundamental EU Code: UEF 1.3 Credits: 9 Coefficients: 5** | Fundamentals of Data Science | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:30 | 40% | 60% |
| | Complexity of issues | 4 | 2 | 1h30 | 1h30 | | 45:00 | 55:00 | 40% | 60% |
| **Fundamental EU Code: UEF 2.3 Credits: 9 Coefficients: 5** | Advanced databases | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| | software engineering | 4 | 2 | 1h30 | 1h30 | | 45:00 | 55:00 | 40% | 60% |
| **Methodological Unit Code: EMU 1.3 Credits: 9 Coefficients: 6** | Cloud computing | 3 | 2 | 1h30 | | 1h30 | 45:00 | 11:30 p.m. | 40% | 60% |
| | Project management | 3 | 2 | 1h30 | | 1h30 | 45:00 | 30:00 | 40% | 60% |
| | Data analysis | 3 | 2 | 1h30 | 1h30 | | 45:00 | 32:30 | 40% | 60% |
| **Transversal UE Code: UET 1.3 Credits: 3 Coefficients: 1** | Technical English 2 | 3 | 1 | | 1h30 | | 10:30 p.m. | 32:30 | 40% | 60% |
| **Total semester 3** | | **30** | **17** | **10:30 a.m.** | **09:00** | **6:00 am** | **382h30** | **343h00** | | |

**Semester 4: 2nd year of the second cycle , Option: Cyber Security**

| Teaching unit | Materials | Credits | Coefficient | Weekly hourly volume | | | Semester Hourly Volume (15 weeks) | Work Complementary in Consultation (15 weeks) | Assessment method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entitled | | | Course | TD | TP | | | Continuous monitoring | Review |
| **Fundamental EU Code: UEF 1.4 Credits: 10 Coefficients: 6** | machine learning | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| | Formal methods for security | 5 | 3 | 1h30 | 1h30 | | 45:00 | 55:00 | 40% | 60% |
| **Fundamental EU Code: UEF 2.4 Credits: 8 Coefficients: 4** | System and network administration | 4 | 2 | 1h30 | | 1h30 | 45:00 | 55:00 | 40% | 60% |
| | Advanced Cryptography | 4 | 2 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| **Methodological Unit Code: EMU 1.4 Credits: 9 Coefficients: 6** | Network security | 3 | 2 | 1h30 | | 1h30 | 45:00 | 45:00 | 40% | 60% |
| | Operating system security | 3 | 2 | 1h30 | | 1h30 | 45:00 | 45:00 | 40% | 60% |
| | Information systems security audit | 3 | 2 | 1h30 | 1h30 | | 45:00 | 45:00 | 40% | 60% |
| **Discovery Teaching Unit Code: UED 1.4 Credits: 3 Coefficients: 2** | Biometrics | 3 | 2 | 1h30 | | | 10:30 p.m. | 45h00 | | 100% |
| **Total semester 4** | | **30** | **18** | **12:00 p.m.** | **6:00 am** | **07:30** | **382h30** | **400h00** | | |

**Semester 5 : 3rd year of second cycle , Option: Cyber Security**

| Teaching unit | Materials | Credits | Coefficient | Weekly hourly volume | | | Semester Hourly Volume (15 weeks) | Work Complementary in Consultation (15 weeks) | Assessment method | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Entitled | | | Course | TD | TP | | | Continuous monitoring | Review |
| **Fundamental EU Code: UEF 1.5 Credits: 10 Coefficients: 6** | Software Security | 5 | 3 | 1h30 | | 1h30 | 45:00 | 55:00 | 40% | 60% |
| | Infrastructure Security | 5 | 3 | 1h30 | 1h30 | 1h30 | 67:30 | 55:00 | 40% | 60% |
| **Fundamental EU Code: UEF 2.5 Credits: 9 Coefficients: 5** | trust management | 5 | 3 | 1h30 | 1h30 | | 45:00 | 55:00 | 40% | 60% |
| | Technique of intrusion and defense | 4 | 2 | 1h30 | | 1h30 | 45:00 | 55:00 | 40% | 60% |
| **EU Methodological Code: UEM 1.5 Credits: 8 Coefficients: 4** | Data anonymization | 4 | 2 | 1h30 | 1h30 | | 45:00 | 30:00 | 40% | 60% |
| | ethical hacking | 4 | 2 | 1h30 | | 3:00 | 67:30 | 55:00 | 40% | 60% |
| **Discovery Teaching Unit Code: UED 1.5 Credits: 3 Coefficients: 2** | Security policies and legal aspects | 3 | 2 | 1h30 | | | 10:30 p.m. | 40:00 | | 100% |
| **Total semester 5** | | **30** | **17** | **10:30 a.m.** | **04:30** | **07:30** | **337h30** | **345h00** | | |

**Semester 6 : 2nd year of second cycle , Option: Cyber Security**

Internship in a company sanctioned by a dissertation and a defence.

| | VH | Credit | coefficient |
|---|---|---|---|
| **Personal work** | 300 | 15 | 07 |
| **Company internship** | 220 | 10 | 05 |
| **Management** | 80 | 05 | 03 |
| **Total Semester 6** | 600 | 30 | 15 |

**Evaluation of the End of Cycle Project**

- Scientific value (Jury assessment) /6
- Dissertation writing (Jury assessment) /5
- Presentation and answer to questions (Jury assessment) /5
- Appreciation of the supervisor /4

## III -Detailed program by subject

## A. Detailed program of Semester 1

**Semester: S1**
**Course unit: UEF1.1**
**Matter 2: Operating System**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credits: 3**
**Rating: 5**

## TEACHING OBJECTIVES:

- Master the main internal mechanisms of operating systems and their application.
- Deepen the various useful concepts for the design of an operating system or system programming as well as distributed operating systems.

## RECOMMENDED PRIOR KNOWLEDGE:

- Number systems and basic computer components
- The basics of computer architecture
- Basics of operating systems.

## MATERIAL CONTENT:

**Chapter 1:** Introduction
- Operating system concept.
- Functions and roles.
- Examples of operating systems (Windows, Unix, Android, etc.).

**Chapter 2:** Processes, Threads, Concurrency and Synchronization
- Definitions
    - Program concept.
    - Process concept.
    - Thread concept.
    - Resource concept.
    - Concept of work (Job).
- Different states of a process.
- Process hierarchies.
- Relations between processes (competition and synchronization).
- Process scheduling techniques:
    - Criteria (Fairness, efficiency, response time, execution time, yield).
- Scheduling algorithms (among the most used):
    - Tourniquet (Round Robin RR).
    - First-in, first-served or FCFS (First Come First-Served) algorithm.
    - Shortest Job First (SJF) algorithm.
    - Algorithm of the shortest remaining time or SRT (Shortest Remaining Time).
    - Algorithm with priority.

**Chapter 3:** Memory Management
- Objectives of a memory manager:
    - Role.

    - Requirement.
- Functions.
- Memory Sharing Modes:
    - Monoprogrammed system.
    - Multiprogrammed system:
        - Fixed partitions.
        - Variable partitions.
- Memory Protection:
    - Monoprogrammed system.
    - Multiprogrammed system.
- Codeshare:
    - Shared code.

**Chapter 4:** File Systems and I/O
- File systems:
    - Definitions.
    - The physical medium:
        - Physical formatting.
        - The disk size.
        - Addresses on disk.
        - Access times:
            - Read time of a sector.
            - Wait for a sector.
            - Change track.
        - Logical formatting.
    - Organization of disk space.
    - Management of free blocks.
    - The main file systems.
- Entries exits :
    - Definition of an I/O.
    - I/O types.
    - Organization of transfers (I/O instructions, hardware/software functional division of an I/O).
    - I/O control modes: synchronous, asynchronous, channel mode.
    - Simultaneous I/O management.

**Chapter 5:** Deadlock
- Models.
- Prevention.
- Avoidance.
- Detection/Healing.

**Chapter 6:** Virtualization and the Cloud
- Virtualization.
- Cloud computing.
- Cloud computing and virtualization.

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Silberschatz, A. , and Gagne, G. , and Galvin, P. B., " *Operating system concepts",* Tenth Edition, Edition Wiley, 2018.

2. Stallings, W., " *Operating Systems, Internals and Design Principles* ", Prentice-Hall Edition, 2009.

3. Tanenbaum, AS, " *Operating Systems* ", 3rd Edition , Pearson Publishing , 2008.

4. Silberschatz, A. , and Galvin, P. , Baer and Gagne, G. , *"Principles applied to operating systems with Java"* , Edition Vuibert, 2001.

5. ZERTAL Soumia, " *The Cloud and Virtualization"* , Edition 2.0, 2020.

**Semester: S1**
**Course unit: UEF1.1**
**Subject 2: Networks 1**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credits: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this course is to introduce the student to the concepts of local networks: their technologies, their architectures, the related protocols. The student will therefore be able to ultimately define a local network architecture with an IP addressing plan.

This course will be accompanied by a TD and a TP per week.

**RECOMMENDED PRIOR KNOWLEDGE:**

- Basics of electricity and electronics
- Basic operating systems

**MATERIAL CONTENT:**

**Chapter 1. General information on networks (4h)**
1. Why a network, what is a network?
2. Evolution of computer networks
3. Network topologies
4. Switching techniques
5. Classification of networks according to size (LAN, WAN, etc.)
6. Classification of networks according to access (Public and private)
7. Vision of networks by telecommunications or computing (PSTN, PSTN 64, packet switching, satellite)
8. Networks user perspective
9. The need for standardization
10. Software abstraction (OSI model, TCP/IP and service primitives)
11. Summary and issues to study (architectures, protocols)

**Practical work** (Know the basic elements, network equipment and tools to have a network connection)

**Chapter 2. Data transmission (6h)**
1. Definitions
2. Link modes (simplex, half duplex, full duplex)
3. Reminder: serial/parallel transmission - synchronous/asynchronous.
4. Notion of bandwidth and transmission rate
5. Transmission Mode (Coding/Modulation)
6. Multiplexing (time, frequency) and ADSL (as a case study)
7. Characteristics of transmission media
8. Characteristics of standardized modems

**Practical work** (DCE-DTE junction (Null modem) and case study)

**Chapter 3. Data Binding (6h)**

1. Definitions and role
2. Notion of frames
3. Communication Channel Allocation Protocols

4. Error Protection
5. Examples of data link layer protocols
**Practical work** (Study of collision phenomena)

**Chapter 4. Local Area Network Technology (8h)**

1. Ethernet Technology
2. WIFI technology
3. Other Technologies (personal networks: bluetooth, etc.)
**Practical work** (Switch operation, PacketTracer, vlan operation, cabling, design and configuration)

**Chapter 5. Addressing and Routing (6h)**

1. Remote access, extension of local networks to extended networks
2. Presentation of the role of the network layer (addressing and routing)
3. IP addressing of a machine
4. Subnet addressing
5. Routers, gateways and bridges.
6. Static Routing
7. Automatic machine configuration protocols (ARP, ICMP)
8. IPV6 Addressing
**Practical work** (IP addresses, ARP and ICMP protocols, Packet tracer simulator, routing)

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Mühlethaler, P., *"802.11 and wireless networks"* , Eyrolles, 2002.

2. Cisco system (Paris), Soubrier, C., *"Network architecture and case studies"* , Campus Press, 1999.

3. Anything, L., *"Local networks and intranet"* , Lavoisier, 2003.

**Semestre : S1**
**Unité d'enseignement : UEF 2.1**
**Matière 1 : Bases de données**
**VHS : 67h30 (Cours : 1h30, TD : 1h30, TP : 1h30)**
**Coefficient : 3**
**Crédits : 5**

**TEACHING OBJECTIVES:**

The database course allows the introduction of the field of design and manipulation of data as well as the use of technologies related to the field.

**RECOMMENDED PRIOR KNOWLEDGE:**

Algorithms and data structures, file structures, Mathematical Logic.

**MATERIAL CONTENT:**

**Chapter 1. Concepts Data Modeling**

1. Reminder of basic modeling concepts (Association Entity and UML)
2. Integrity Constraint Modeling

**Chapter 2. The Relational Model**

1. Basic concepts of the model
2. Transition from the entity-association to the relational model
3. Normalization theory
4. Relational Algebra
5. Algebraic language

**Chapter 3. Manipulating Databases**

1. Components of the SQL language
2. Data DefinitionLanguage
3. Data Manipulation Language

**Chapter 4. Database Administration**

1. Index management and manipulation
2. Transaction Management and Handling
3. Database security management

**ASSESSMENT METHOD** : Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Churcher, C., *"Beginning Database Design, from novice to professional",* Apress, 2007.

2. Teorey, T., *"Database modeling and design"* , Morgan Kaufmann, 1998.

3. Giles Roys, NB, *"Database design with UML"* , Presses Université Quebec, 2007.

4. Gardarin, G., *"Databases"* , Eyrolles, 1987.

5. Meires, A., *"Practical introduction to databases"* , Eyrolles, 2005.

6. Soutou, C., *“From UML to SQL, Database Design”* , Eyrolles, 2002.

**Semester: S1**
**Course unit: UEF 2.1**
**Subject 2: Software Engineering**
**VHS: 45h00 (Course: 1h30, TD, 1h30)**
**Credits: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this course is to understand the software development process, in particular the analysis and object-oriented design phases.

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of information systems.

**MATERIAL CONTENT:**

**Chapter 1** : Introduction to Software Engineering

**Chapter 2:** Introduction to software specification methods.

**Chapter 3:** Introduction to object design.

**Chapter 4:** Presentation of the modeling language UML (Unified Modeling Language).

**Chapter 5** : Detailed presentation of UML diagrams

- Class diagram
- Object diagram
- Use case diagram
- Sequence diagram and communication diagram
- Activity diagram
- State-transition diagram

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES**

1. Gustafson, D., *"Software Engineering"* , Dunod, Paris, 2003

2. Lemoine, M., *"Software Engineering Brief"* , Masson, Paris, 1996

3. Roques, P., *"UML 2 by practice - Case studies and corrected exercises"* , eyrolles editions, 2006.

4. Gabay, J., Gabay, D., *"UML 2 Analysis and Design, Guided Implementation with Case Studies"* , Dunod, 2008.

5. Charroux, B., Osmani, A., Thierry-Mieg, Y., *"UML 2, modeling practice"* , synthex collection, 2009.

**Semester: S1**
**Course unit: EMU 1.1**
**Subject 1: Operational Research 1**
**VHS: 45h00 (Course: 1h30, TD: 1h30, TP: 1h30 )**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this subject is to initiate the student to interpret, structure and model data and to be able to solve optimization and scheduling problems.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basic notions of mathematics acquired from the first and second year of the course.

**MATERIAL CONTENT:**

**Chapter 1 . Fundamentals of Graph Theory**
1.1 Introduction
1.2 Directed graphs
1.2.1 Definitions
1.2.2 Predecessors, successors and neighbors of a vertex
1.2.3 Degree of a vertex
1.2.4 Isolated vertex and pendent vertex
1.2.5 Single graph and multiple graph
1.2.6 Matrix representation
1.2.6.1 Adjacency matrix
1.2.6.2 Impact matrix
1.3 Undirected graphs
1.4 Some important graph classes
1.4.1 Simple graph
1.4.2 Null graph
1.4.3 Complete graph
1.4.4 Complementary graph
1.4.5 Inverse graph
1.4.6 Bipartite graph
1.4.7 Planar graph
1.4.8 Reflective graph
1.4.9 Symmetric graph
1.4.10 Antisymmetric graph
1.4.11 Transitive graph
1.5 Subgraphs

**Chapter 2. Path problems in a graph**
2.1 Channels and Paths
2.1.1 Channels
2.1.2 Paths
2.1.3 Some properties
2.2 Cycles and Circuits
2.2.1 Cycles
2.2.2 Tours

5.2 Conditions of existence of solutions
5.3 Resolution algorithms
5.3.1 Bellman's algorithm
5.3.2 Dijkstra's algorithm
5.3.3 Ford's algorithm

**Chapter 6. Problem of Flows**
6.1 Position of the problem and generalities
6.2 Minimum cut problem
6.3 Ford-Fulkerson algorithm

**Chapter 7. Scheduling problem**
7.1 Introduction
7.2 Definitions and generalities
7.3 Project scheduling methods
7.4 Gantt chart
7.5 PERT method
7.5.1 Dummy task
7.5.2 Calculation of stage dates
7.5.3 Calculation of task dates
7.5.4 Total and free margins of a job
7.5.5 Critical tasks and path
7.5.6 The steps of the PERT method
7.6 BPM method
7.6.1 Construction of a BPM graph
7.6.2 Task date calculations

**Chapter 8. Dynamic Programming**
8.1 Principle of optimality
8.2 Bellman's equation
8.3 Longest common subsequence
8.4 Dynamic programming in trees
8.5 Backpack problem
8.6 Traveling salesman problem

**ASSESSMENT METHOD** : Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Roseaux, *"Operational Research Exercises: Volume 3, Linear Programming and Extensions of Classical Problems"* . Mason. 1991

2. Bazaraa M., and Jarvis, JJ, *"Linear programming and network flows"* , J. Wiley and Sons, 1977.

BENGHEZAL AF, "Linear Programming", OPU, 2nd Edition, Ben Aknoun, Algiers, 2006

**Semester: S2**
**Course unit: EMU 1.1**
**Topic 2: Random Processes and Queues**
**VHS: 67h30 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

Allow the student to deepen his knowledge of random processes, Markov chains, queues and introduce him to the formulation of problems by modeling in network systems.

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of statistics, basic probabilities and mathematical formalism are necessary to follow this module.

**MATERIAL CONTENT:**

**PART 1: Random processes and Markov chains**

**Chapter 1. Introduction to Random Processes**
1.1Notion of Random Process
1.2 Stationary processes (strictly stationary, weakly stationary, with stationary increments )
1.3 Processes with independent increments
1.4 Recurring processes
1.5 Notion of ergodicity
1.6 Dependency relationship

**Chapter 2. Discrete-time Markov chains**
2.1 Definitions
2.2 Fundamental properties
2.2.1 Chapman–Kolmogorov relationship
2.2.2 Probability measure of a Markov chain and transient regime.
2.3 Classification of states and performance parameters
2.3.1 Accessible States
2.3.2 Recurrent and transient states
2.3.3 Periodicity
2.4 Steady state and limit distribution
2.5 Stationary distributions
2.6 Absorbing Markov chains and fundamental matrix
2.6.1 Absorption times
2.6.2 Absorption probabilities

**Chapter 3. Continuous-time Markov chains**
3.1. Transient analysis
3.2. First pass time
3.3. The standardization method
3.4. Poisson process
3.4.2 Definitions and main properties
3.4.3 Poisson process and exponential law
3.4.4 Decomposition, superposition
3.4.5 *Poisson process* and uniform law
3.5 Birth and death process

6.5 Discrete Event Simulation (Queue Simulation)

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Gaver DP and Thompson GL, *"Programming and Probability Models in Operations Research",* Brooks/Cole publishing company, 1973.

2. Moder JJ and Elmaghrabi SE, *"Handbook of Operations Research: Foundations and Fundamentals"* , Van Nostrand Reinhold Company, 1978.

**Semester: S1**
**Course unit: EMU 1.1**
**Subject 3: Theory of languages**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**
This course presents the foundations of programming languages and develops the lexical and syntactic analysis phases of a compiler. Students will know, at the end of the semester, how to make a lexical analyzer and a syntactic analyzer.

**RECOMMENDED PRIOR KNOWLEDGE:**

Know the basic notions of algorithms, programming and mathematics.

**MATERIAL CONTENT:**
**Chapter 1:** Introduction and Objectives

**Chapter 2:** Alphabets, Words, Languages

**Chapter 3:** Grammars

1. Definitions
2. Derivation and generated language
3. Bypass shaft
4. Chomsky hierarchy

**Chapter 4:** Finite state automata

1. Deterministic AEFs
2. Representations of an automaton
3. Equivalent and complete automata
4. Non-deterministic AEFs
5. Automata and regular languages (transformations and properties)

**Chapter 5:** Regular Expressions

1. Definitions
2. Kleene's theorem
3. star lemma
4. Properties of a regular grammar
5. Transformations of a grammar
6. Reduced grammar
7. Proper grammar
8. Elimination of left recursivities
9. Normal forms

**Chapter 6:** Minimization of a finite state automaton

**Chapter 7:** Algebraic Languages

**Chapter 8:** Battery-Powered Automata

1. Definition

2. Configuration, transition and calculation
3. Acceptance criteria
4. Deterministic battery-powered automata

**Chapter 9:** Turing Machine

1. Definition
2. Configuration, transition and calculation
3. Acceptance

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Floyd, R., Biegel, R., *"Machine Language: An Introduction to Computability and Formal Languages"* , Thomson Publishing, France, 1994.

2. Hopcroft, JE, Ullman, JD, *"Introduction to Automata Theory and Computation"* , Addison Wesley Publishing Company, 1979.

3. Wolper, P., *"Introduction to Computability"* , InterEditions, Paris, 1991.

4. M. Autebert Theory of languages and automata. 1994, Mason. J. Hopcroft, J. Ullman. Introduction to Automata Theory, Languages and Compilation 1979, Addison-Wesley

**Semester: S1**
**Course unit: UET 1.1**
**Subject 1: Technical English 1**
**VHS: 10:30 p.m. (Class: 1:30 a.m.)**
**Credits: 3**
**Coefficient: 1**

**TEACHING OBJECTIVES:**
The objective of this course is to familiarize the student with the concepts of computing in English.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basic English.

**MATERIAL CONTENT:**

**Unit 1:** Hobby, Addiction, or Future Job?

**Unit 2:** Computing

**Unit 3:** The Development of Computers

**Unit 4:** Personal Computers

**Unit 5:** Computer and Crime

**Unit 6:** Computer Security

**Unit 7:** Virtual Reality

**Unit 8:** IT Revolution

**Unit 9:** Humor the Computer

**ASSESSMENT MODE:** Exam (100%).

**BIBLIOGRAPHIC REFERENCES:**

1. *"English for Computer Science Students"* , Moscow, "FLINT" Publishing House, 2017, ISBN 978-5-89349-203-3

2. *"English++ English for Computer Science Students"* , Complementary Course Book open book, Jagiellonian Language Center Jagiellonian University Cracow, 2008.

# A. Detailed program of Semester 2

**Semester: S2**
**Course unit: UEF 1.2**
**Subject 1: Distributed Architecture and Intensive Computing**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this course is to introduce the student to the concepts implemented in the organization and operation of modern architectures (RISC technology, pipelining techniques, memory hierarchy, classification of multiprocessor architectures, etc.). It also involves mastering the basic mechanisms of high performance computing, evaluating the performance of an architecture and understanding the vision of parallelism and multiprocessor architectures.

At the end of this course, the student should be able to extract from a modern computer its main architectural characteristics, to evaluate the performance of its CPU and to understand the functioning and the interaction between its different functional units.

**RECOMMENDED PRIOR KNOWLEDGE:**

- Basic computer architecture
- Basic operating systems

**MATERIAL CONTENT:**

**Chapter 1:** Foundations of Conventional Architectures

Technological evolution, Moore's Law, intrinsic performances and limits

**Chapter 2:** Introduction to Advanced Architecture and Parallel Computing

- Basics
- SIMD, MISD, MIMD architectures
- Computing grid, computer clusters, network of connected machines

**Chapter 3:** Supercomputers and microprocessors

- Principle, operation and performance, RISC vs CISC
- Instruction set and functional specification
- Pipeling techniques and ILP (Instruction LevelParallelism)

**Chapter 4:** Performance Analysis of Multiprocessor Architectures

- Calculation models
- IPC, CPI, latency, acceleration, throughput

**Chapter 5:** Shared Memory Architecture

- Organization and hierarchy of memory and cache memory
- Architecture, operation, consistency

**Chapter 6:** Message Passing Architecture

- Introduction, Models
- Architecture Switching and Routing

**Chapter 7:** Operation of High Performance Computing (HPC) Systems

- HPC and HPC operating systems
- Approaches
- Historical
- Current trends

**Chapter 8:** Case Studies

- Light core systems
- - Unix/Linux systems
- - Multi-core systems

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Gerofi, B., Ishikawa, Y., Riesen, R., & Wisniewski, R. W, *"Operating Systems for Supercomputers and High Performance Computing"* , Vol.1, Springer, 2019.

2. Zimmer, A., *"The Anatomy of a High-Performance Microprocessor: A Systems Perspective"* , Edition Har/Cdr, 1998.

3. Tanenbaum, A. S, and Bos, H., *"Modern operating systems"* , Edition Pearson, 2015.

4. El-Rewini, H., & Abd-El-Barr, M., *"Advanced computer architecture and parallel processing"* , Edition Wiley, Vol. 42, 2005.

5. University of Wisconsin-Madison. WWW Computer Architecture Page. http://pages.cs.wisc.edu/~arch/www/books.html .

**Semester: S2**
**Course unit: UEF 1.2**
**Subject 2: Networks 2**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credits: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this course is to introduce the student to long distance networks and associated technologies. The student will also learn dynamic routing, the concept of quality of service in networks and mobile networks. The course attaches particular interest to the transport layer; network and certain application layer protocols, notably DNS.

This course will be accompanied by a TD and a TP per week.

**RECOMMENDED PRIOR KNOWLEDGE:**

- Network 1
- Basics of electricity and electronics
- Basic operating systems

**MATERIAL CONTENT:**

**Chapter 1:** Reminder on networks and the Internet

**Practical work** (Discovery of internet architecture as well as NAT, private/public address)

**Chapter 2:** Transport Protocols

1. Role and position in the OSI model - TCP/IP
2. Notion of flow control and error recovery
3. port concept
4. TCP protocol (connected mode):
5. UDP protocol (unconnected mode)
6. Network programming interface: Sockets

**TP** ( Using Telnet, FTP, WireShark )

**Chapter 3:** Addressing and Dynamic Routing

1. Reminders on IPV4 addressing
2. Multicast communication in IP networks
3. Dynamic routing and Internet routing (RIP, OSPF, BGP)
4. Advanced study of IPV6 addressing: self-configuration mechanisms, mobility management

**TP** (Dynamic Routing Configuration (RIP, OSPF and BGP))

**Chapter 4:** Quality of Service (QoS) in IP Networks

1. Definitions and issues.
2. Mechanisms to manage Quality of Service (QoS)
3. QoS architectures: best effort, IntServ, DiffServ; Controlled load service.
4. The RSVP signaling protocol
5. Congestion control and flow control.
6. IPv6 and QoS;

**TP** (Opening a QoS mechanism on routers)

**Chapter 5:** Wide Area Networks (Broadband)

1. Broadband networks: architecture, techniques, switching and routing;
2. Long distance technologies (PDH.SDH)
3. Optical networks (SONET/SDH): WDM, C-WDM, DWDM multiplexing techniques
4. Operator access: Types of interface, Level of availability, Constraints, Frame relay, ATM.
5. MPLS and GMPLS technology: switching and signaling techniques.

**Chapter 6:** Introduction to Mobile Networks

1. Mobile radio telecommunication networks: GSM, GPRS, UMTS.
2. Standards (3G and derivatives): architecture and protocols.
3. Deployment and administration of mobile phone technologies.

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Mühlethaler, P., *"802.11 and wireless networks"* , Eyrolles, 2002.

2. Cisco system (Paris), Christian Soubrier, *"Network architecture and case studies"* , Campus Press, 1999.

3. Tanenbaum, A., *"Networks: Architectures, Protocols, Applications"* . Ed.: InterEditions, 3rd edition, 1997.

4. Kurose, JF and Ross, KW, *"Computer Networking: A Top-Down Approach Featuring the Internet",* Pearson, 3rd edition, 2004.

5. Ferguson, P., Huston, G., *"Quality of Service: Delivering QoS on the Internet and in Corporate Network"* , Wiley, 1st edition, 1998 .

Jain, R., *"The art of computer systems performance analysis"* , John Wiley & Sons, 2008.

**Semester: S2**
**Course unit: UEF 2.2**
**Subject 1: Artificial Intelligence**
**VHS: 67h30 (Class: 01h30, TD: 1h30, Lab: 1h30)**
**Credits: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

After having acquired this material, the student will be able to:
- Solve Artificial Intelligence problems.
- Design artificial intelligence systems (expert systems, etc.).
- Be able to study advanced artificial intelligence techniques.

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of mathematics, logic and a mastery of programming.

**MATERIAL CONTENT:**

**Chapter 1:** General introduction

**Chapter 2:** 1st order calculation

**Chapter 3:** Production Rule Systems (SP)

**Chapter 4:** Rebuttal System by Resolution

**Chapter 5:** Search Strategies

**Chapter 6:** Expert systems

**Chapter 7:** Planning in Robotics

**Chapter 8:** Some AI languages

**Chapter 9:** CSP Problems

**Chapter 10:** Introduction to advanced AI.

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES** :

1. Nilsson, NJ, *"Principles of artificial intelligence"* , Morgan Kaufmann, 2014.

2. Ginsberg, M., *"Essentials of artificial intelligence"* , Newnes, 2012.

3. Nilsson N., and Nilsson, NJ, *"Artificial intelligence: a new synthesis"* , Morgan Kaufmann, 1998.

4. Russell S., and Norvig, P., *"Artificial intelligence: a modern approach"* , Aima.cs.berkeley.edu, 2002.

5. Haton, JP, Bouzid N., and Charpillet, F., *"Reasoning in artificial intelligence"* , Intereditions, 1991.

**Semester: S2**
**Course unit: UEF 2.2**
**Subject 2: Computer security**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credits: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**
This course presents the fundamental aspects of computer security, in particular, aspects of cryptography and key management. The student must therefore know how to carry out risk analyses, use some cryptographic tools for key exchanges and certification.

**RECOMMENDED PRIOR KNOWLEDGE:**

Know the basic notions of algorithms, operating systems, networks and mathematics.

**MATERIAL CONTENT:**

**Chapter 1:** Basic Concepts

1. Motivation
    - Raising students' awareness of security issues through numbers
    - Raising students' awareness of security problems using examples: viruses, worms, Trojan horses, spyware, spam, etc.
2. General
    - Definition of computer security
    - Objectives of computer security
    - Threats/ Levels of vulnerabilities
3. Risk analysis

**Chapter 2:** Classic Cryptography

1. Objectives of cryptography (confidentiality, integrity, authentication, etc.)
2. Cryptography/cryptanalysis definition
3. Encryption/Decryption/Encryption key and concept of entropy
4. Substitution algorithm: Caesar cipher, VIGENERE cipher.
5. Algorithm of Transposition: the Assyrian technique.

**Chapter 3:** Modern Cryptography

1. Symmetric encryption (DES, AES, RC4)
2. Asymmetric encryption (RSA, ElGamal, EC)

**Chapter 4:** Signature and hash functions

- Cryptographic hash and integrity
- MAC/HMAC and authentication
- Electronic signature

**Chapter 5:** Key Management

- Presentation of the problem
- Key exchange by Diffie-Hallman
- Public key infrastructure Decentralized model Hierarchical model and certificates

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES**

1. Talligs, W., *"Network Security: Applications and Standards"* , Vuibert, 2002.

2. Schneier, B., *"Applied Cryptography: Algorithms, Protocols and Source Codes in C"* , Vuibert, 2002.

3. Dubertret, G., *"Initiation to cryptography"* , Vuibert, 1998.

**Semester: S2**
**Course unit: UEM 1.2**
**Subject 1: Operations Research 2**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this subject is to introduce the student to the theory of optimization problems, design and implementation of resolution algorithms, resolution of combinatorial optimization problems by several approaches.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basic notions of mathematics acquired from the first and second year of the course.

**MATERIAL CONTENT:**

**Part I: Linear Programming**

**Chapter 1** : Problem Formulation

1.1 General introduction
1.2 Concepts of mathematical model
1.3 Formulation of a linear model
1.4 General form of a linear program

**Chapter 2:** Concepts fundamentals of linear programming

2.1 Graphic Resolution
2.2 Reminders of Linear Algebra
2.2.1 Vector Space
2.2.2 Matrices
2.2.3 System of Equations
2.2.4 Convex Sets
2.3 Basics and basic solutions
2.3 Characterization of the extreme points
2.4 Optimality at an extreme point
2.5 Optimality criteria
2.5.1 Formula for increments of the objective function
2.5.2 Optimality criterion
2.5.3 Sufficient condition for the existence of an unbounded solution

**Chapter 3:** Simplex method and its variants

3.1. Simplex method
3.1.1 Basic concepts
3.1.2 Standard form of a linear program
3.1.3 Characterization of the solutions of a linear program
3.1.4 Principle of the simplex algorithm
3.1.5 Statement of the simplex algorithm

3.2 Complements on the simplex algorithm
3.2.1 The simplex for the minimization case
3.2.2 Models with mixed constraints (Absence of a realizable basic solution of departure)
3.2.3 Two-phase method
3.2.4 Big-M method (artificial basis method)
3.2.5 Typical case (Degenerate linear program, unbounded linear program, program linear with multiplicity of solutions, non-feasible program)

**Chapter 4:** Duality and post optimality

4.1 Duality in linear programming
4.1.1 Introduction
4.1.2 Formulation of the dual
4.1.3 Theoretical aspects of duality
4.1.4 How to obtain Primal-Dual optimal solutions
4.1.5 Economic interpretation of dual variables
4.1.6 Determination of optimal table of the dual
4.2 Post-optimal analysis and economic interpretation
4.2.1 Occasional changes to parameters $a_{ij}, b_j$ and $c_j$
4.2.1.1 Variation of objective coefficients
4.2.1.2 Variation of the second member
4.2.1.3 Modification in the matrix of the constraints
4.2.2 Sensitivity Analysis
4.2.2.1 Continuous variation of an objective coefficient
4.2.2.2 Continuous variation of the second member
4.2.2.3 Adding a new variable
4.2.2.4 Adding a new constraint

**Chapter 5:** Transport and Assignment Problem

5.1 Transportation Problem
5.1.1 Position of the problem
5.1.2 Mathematical Model
5.1.3 Condition of existence of an optimal transport solution
5.1.4 Table and Graph associated with a transport problem
5.1.5 Finding an Initial Basic Feasible Solution
5.1.6 Method of potentials for the search for an optimal solution
5.2 Assignment Problem
5.2.1 Mathematical model
5.2.2 Primal-dual approach applied to the assignment problem

**Part II: Combinatorial optimization**

**Chapter 1:** Class problems

1.1. Notion of complexity
1. 2. Class P
1.3. The NP class
1.4. NP-complete problems
1.5. Classification of problems

**Chapter 2:** Integer Programming

2.1. Methods by separation and evaluation "Branch and Bound"
2.1.1. General scheme of separation and evaluation methods
2.1.2. Possible strategies for the choice procedure
2.1.3. Application to the traveling salesman problem
2.1.4. Application to the backpack problem
2.2. Cutting methods

**Chapter 3:** Boolean Programming

3.1 Introduction
3.2 Recovery and partitioning problem
3.3 BALAS algorithm

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Roseaux, *"Operational Research Exercises: Volume 3, linear programming and extensions of classical problems"* , Masson, 1991

2. Bazaraa, M., and Jarvis, JJ, *"Linear programming and network flows"* , J. Wiley and Sons, 1977.

3. Benghezal AF, "Linear Programming", OPU, 2nd Edition, Ben Aknoun, Algiers, 2006

**Semester: S2**
**Course unit: EMU 1.2**
**Subject 2: Formal Methods**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

This module is an introduction to the theory and applications of formal methods in the field of computer science. It covers the mathematical specification, modeling and verification of systems.

**RECOMMENDED PRIOR KNOWLEDGE:**

Fundamental mathematics, mathematical logic and algorithms.

**MATERIAL CONTENT:**

**Chapter 1. Formal methods for computer science**

- Critical systems
- System validation and verification
- Rigorous specification of systems

**Chapter 2. Formalisms for System Specification**

- State transition system
- Z language
- Temporal logic

**Chapter 3. Formal validation and verification**

- Model Checking Algorithms
- Event-B formal method

**EVALUATION METHOD:** Examination (60%), continuous monitoring (40%) .

**BIBLIOGRAPHIC REFERENCES** :

1. Clarke Jr, EM, Grumberg, O., Kroening, D., Peled, D., & Veith, H, *"Model checking"* , MIT press, 2018.

2. Abrial, JR, *"Modeling in Event-B: system and software engineering"* , Cambridge University Press, 2010.

3. Christel, B., and Katoen, JP, *"Principles of model checking"* , MIT press, 2008.

4. Boulanger, JL, *"Implementation of method B"* , Hermès - Lavoisier, 2003.

**Semester: S2**
**Course unit: EMU 1.2**
**Subject 3: Numerical Analysis**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

• Acquire the basis of numerical analysis methods
• Acquire programmable standard numerical methods to solve complex problems
• Solving differential equations by different methods
• Calculation of eigenvalues

**RECOMMENDED PRIOR KNOWLEDGE:**

Basic notions of mathematics acquired from the first and second year of the course.

**MATERIAL CONTENT:**

**Chapter 1:** Solving equation f(n)=0

**Chapter 2:** Polynomial Interpretation

C **hapter 3** : Theory of approximations

**Chapter 4:** Resolution of linear systems by direct method

**Chapter 5:** Resolution of linear systems by alterative methods

**Chapter 6:** Numerical Derivation

**Chapter 7:** Numerical integration

**Chapter 8:** Differential Equations

**Chapter 9:** Calculation of eigenvalues

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Ciarlet, PG, *"Introduction to matrix numerical analysis and optimization – Courses and corrected exercises"* , Dunod, 2006.

2. Schatzman, M., *"Numerical analysis - a mathematical approach - lessons and exercises"* , Dunod, 2001.

3. Sibony, M., Mardon, J., *"Linear and nonlinear systems, Numerical analysis T1"* , Hermann, 1984.

**Semester: S2**
**Course unit: UED 1.2**
**Subject 1: Entrepreneurship and digital start-ups**
**VHS: 10:30 p.m. (Class: 1:30 a.m.)**
**Credits: 3**
**Coefficient: 1**

**TEACHING OBJECTIVES:**

This module aims to promote the innovative/creative spirit among graduates and to promote the development of an entrepreneurial culture in the Digital sector in Algeria. The objectives of this course are:

- Develop all the entrepreneurial skills and knowledge essential to the process of creating a digital startup;
- Develop a Business Plan to validate and implement innovative digital technology projects;
- Acquire the necessary know-how to lead a technological innovation project in the digital world through the application of creativity methods;
- Create and animate an entrepreneurial dynamic within a start-up or company (small and medium-sized companies or large groups).

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of business, economics and mathematics is required to take this course.

**MATERIAL CONTENT:**

**Chapter 1: Introduction to entrepreneurial culture and start-ups**

- Around entrepreneurship and start-ups;
- Entrepreneurship triggers/inhibitors;
- Become an entrepreneur and create your start-up;
- Entrepreneurial potential;
- The entrepreneurial culture.

**Chapter 2 : Intellectual properties**

- Licences
- Copyright
- Marks
- Designs

**Chapter 3: Entrepreneurial situations and forms of start-up creation**

- The process of creating a start-up;
- The challenges/risks in creating a start-up;
- Entrepreneurial creativity and innovation;
- What is the business plan?
- Forms of support and incubators.

**Chapter 4: Developing a business model**

- The entrepreneur and his project;
- Business background;
- Environmental and competitive analysis;
- Judicial aspects ;
- Market study and marketing plan;
- Financial forecasts and financial plan.

**Chapter 5: Regulatory framework and financing modalities in Algeria**

- Difficulties of start-up entrepreneurs;
- Creativity and innovation;
- Presentation of a business project
- The knowledge necessary to ensure the management and development of the project.
- Auto-entrepreneurs and micro-enterprises in Algeria
- The legal, fiscal aspects, status of auto-entrepreneurs
- Funding and resources;

**Chapter 6: Startups and Digital**

- Key areas
- Digital marketing and the international market
- Particularities of digital startups

**ASSESSMENT METHOD:** Examination (100%).

**BIBLIOGRAPHIC REFERENCES** :

1. Altintas G., and Kustosz, I., *"Entrepreneurial capacities: from organizations to territories"* , 2018, EMS Editions.

2. Tsagliotis, A., *"Drawing inspiration from successful start-ups"* , 2nd edition, August 2019 Collection, Dunod.

3. Schmitt, C., *"Aide-mémoire – Entrepreneurship, Concepts, Methods and Actions"* , 2019, Dunod.

4. Nurdin, C., and Picamoles, T., *"Start-up strategy, From American myth to French success"* , 2019, Dunod.

## B. Detailed program of Semester 3

**Semester: S2**
**Course unit: UEF 1.3**
**Subject 1: Fundamentals of Data Science and Data Mining**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credits: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

Enable students to understand the principles of Data Mining, Data Analytics and Data Science.

Practical work with python/R/ accompany the theoretical training of this module.

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of statistics, and a mastery of programming and mathematical formalism are necessary to follow this module.

**MATERIAL CONTENT:**

**Chapter 1** . Introduction to Data Science

- Facets and data types
- The data science process
- The big data ecosystem and data science

**Chapter 2** . The data science process

- Data Science Process Overview
- Step 1: Define research objectives and create a project charter
- Step 2: Data Recovery
- Step 3: Clean, integrate and transform data
- Step 4: Exploratory data analysis
- Step 5: Build the models
- Step 6: Presenting Results and Building Applications Above Them

**Chapter 3:** Data science tools

- data storage tools
- Data preparation tools
- Data visualization tools
- Notebook IDE tools
- Complete data science platforms

**Chapter 4** : Basics of data mining

- KDD process
- Life cycle of a data mining project
- Data Mining Tasks and Techniques ,
- Evaluation of models and visualization of results
- Search for frequent patterns
- Case study

**Chapter 5:** Graph Mining:

- Graph structure,
- Notions of graph centers,
- Graph clusters
- Shortest paths.

**Chapter 5** Web Mining:

- Structure search: node, graph (prestige, centrality, popularity),
- Community detection,
- Extraction of sub-graphs under constraints,
- Content mining
- Usual search

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Dietrich, D., *"Data science & big data analytics: discovering, analyzing, visualizing and presenting data"* , Wiley, 2015.

2. Lutz, M., & Biernat, E., *"Data Science: fundamentals and case studies: Machine Learning with Python and R"* , Editions Eyrolles, 2015.

**Semester: S3**
**Course unit: UEF 1.3**
**Topic 2: Complexity of Problems**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

This course allows students to acquire the necessary skills to be able to analyze the complexity of algorithms and problems, which will allow them to design correct and efficient algorithms for solving a given problem.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basics of algorithms and data structures.

**MATERIAL CONTENT:**

**Chapter 1:** Introduction

1. Notion of complexity of problems
2. Complexity of algorithms
3. Landau notation
4. Graph traversal
5. Fixed point theory

**Chapter 2:** Complexity Theory

1. Decision problems and languages
2. Data Representation and Calculation Models
3. Complexity classes
4. Polynomial reductions
5. NP-Completeness

**Chapter 3:** Complexity reduction

1. Top-Down Method (Divide to Solve)
2. Bottom-up method (Dynamic programming)

**Chapter 4:** Troubleshooting

1. Backtracking
2. Hill Climbing
3. Best First Search
4. Branch and Bound
5. Algorithm A*

**Chapter 5** : Imperative Programming

1. Program diagrams
2. Program transformations
3. Formal proofs

**Chapter 6** : Application Programming

1. Lambda-calculus
2. Lisp and higher order functions
3. Proofs by induction
4. Interpretation of functional languages

**Chapter 7** : Declarative Programming

1. Automatic theorem proof
2. Prolog and symbolic manipulations
3. Interpretation of logical languages

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES** :

1. Goldreich, O., *"P, NP, and NP-Completeness: The Basics of Computational Complexity"* , Weizmann Institute of Science, New York, Cambridge University Press, 2010.

2. Hebrard, E., *"Computability, Combinatorics and Complexity"* , LAAS-CNRS, University of Toulouse Midi-Pyrénées, France.

3. Atallah, MJ, Blanton, M., *"Algorithms and Theory of Computation Handbook"* , Second Edition, CRC Press, 2010.

4. Goldreich, O., *"Computational Complexity A Conceptual Perspective"* , Cambridge University Press, 2008.

5. Durand, A., *"The P = NP problem: The complexity of algorithms"* , University Paris 7, France, 2009.

**Semester: S3**
**Course unit: UEF 2.3**
**Topic 1: Advanced Databases**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credits: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

This course has three main objectives:

- Proficiency in relational/object databases and familiarity with SQL3 for querying complex structured data.
- Model semi-structured and semantic data using XML/RDF and querying using XQuery/XPath.
- Overview of NoSQL databases.

**RECOMMENDED PRIOR KNOWLEDGE:**

Have good theoretical knowledge of relational databases, object-oriented modeling, algorithms and programming

**MATERIAL CONTENT:**

The content of this course is articulated around 5 chapters ranging from data modeling to NoSQL databases through complex and semi-structured data models.

**Chapter 1:** Data Modeling

1. Evolution of data and applications
2. Advances in Data Models and Applications

**Chapter 2:** Relational/object model

1. User types concept
2. Type inheritance and references
3. collections

**Chapter 3:** Performance in Databases

1. One-dimensional index structures (sequential, B-trees, hash, clusters)
2. Optimization of execution plans (under Oracle)

**Chapter 4:** Data models and semi-structured languages

1. Syntax and semantics of XML
2. Xquery and XPath query languages

**Chapter 5:** NoSQL Databases and Big Data

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Gardarin, G., *"Databases – Object & Relational"* , Eyrolles, 1999.

2. Garcia-Molina, H., Ullmann, JD, and Widom, J., *"Database systems: the complete book"* , Pearson, 2009.

3. Soutou, C., *"Object programming with Oracle–Techniques and practices"* , Vuibert, 2nd Ed., 2008.

4. Miranda, S., *"Databases: Architectures, relational models and objects"* , SQL3, Dunod, 2002.

5. Bizoï, R., *"PL/SQL for Oracle 12c"* , Eyrolles, Tsoft, 2014.

6. Gardarin, G., *"XML: from databases to Web services"* , Dunod, 2002.

**Semester: S3**
**Course unit: UEF 2.3**
**Subject 2: Software Engineering**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**
At the end of this module, the student should be able to:

- Master the concepts and tools necessary for the proper conduct of software development projects.
- Introduction to the verification and validation of critical software using formal methods.

**RECOMMENDED PRIOR KNOWLEDGE:**

Algorithmic and programming.

**MATERIAL CONTENT:**

This course consists of 5 chapters.

**Chapter 1:** Introduction to Software Engineering

**Chapter 2:** Organizing and Planning Projects

**Chapter 3:** Cost Estimation in Software Development

**Chapter 4:** Software Quality Management

**Chapter 5:** Verification and validation of critical software.

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES** :

1. Hiard, V., *"Management of a web project: planning, piloting and best practices"* , ENI Editions; 2016.

2. Guyomard, M., *"Data structures and formal methods"* , Springer, 2011.

3. Sommerville, I., *"Software Engineering"* , Eight Edition, Addison-Wesley, 2007.

4. Printz, J., Deh, C., Mesdon, B., Trèves, N., *"Costs and duration of IT projects. Practice of estimation models"* , Hermès, 2003.

**Semester: S3**
**Course unit: UEM 1.3**
**Subject 1: Cloud Computing**
**VHS: 45h00 (Course: 1h30, Lab: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

Allow students to understand the main features, services, standards of Cloud Computing. Practical work on Dockers / Swarm / services accompany the theoretical training of this module.

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of statistics, machine learning and a mastery of programming and mathematical formalism are necessary to follow this module.

**MATERIAL CONTENT:**

**Chapter 1** : General Cloud Computing

**Chapter 2:** Cloud Computing Platforms

**Chapter 3:** Virtualization technologies

**Chapter 4:** Infrastructure as a Service

**Chapter 5:** Platform as a Service

**Chapter 6:** Software as a Service

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES** :

1. Foster, I., Zhao, Y., Raicu, I., & Lu, S., *"Cloud computing and grid computing 360-degree compared"* , arXiv preprint arXiv:0901.0131, 2008.

2. Furht, B., & Escalante, A., *"Handbook of cloud computing"* , New York: Springer, Vol. 3, 2010.

**Semester: S3**
**Course unit: EMU 1.3**
**Subject 2: Project Management**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

This course presents the fundamental aspects of project management.

**RECOMMENDED PRIOR KNOWLEDGE:**

Know the basic notions of algorithms, operating systems, networks and mathematics.

**MATERIAL CONTENT:**

**Chapter 1:** Notion of Project

1. Definitions and terminology
2. Evolve in project mode
3. Typology of projects
4. Real examples of projects
5. Failures of projects and more particularly IT projects
6. Key success factors
7. General project management approach

**Chapter 2:** Actors and project organization

1. Main players: users, contracting authority, project management
2. Committees? Why and how?

**Chapter 3:** Communication and group dynamics: Leading a project team

1. Importance of communication
2. Leading a project team: roles played by the members
3. Case studies :
   - Role play (simulation) as part of a project e.g. Launch of an Intranet
   - Conflict negotiation techniques

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES** :

1. Corbel, JC, *"Project Management: Fundamentals, Methods and Tools"* , Ed. d'Organisations, 2005.

2. Fernandez, A., *"The effective project manager* ", Organization Edition, Paris, 2005.

**Semester: S3**
**Course unit: EMU 1.3**
**Subject 3: Data analysis**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credits: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

Allow students to understand the general principles of data analysis methods, depending on the issues they help to answer.

**RECOMMENDED PRIOR KNOWLEDGE:**

Knowledge of descriptive statistics and a mastery of mathematical formalism are necessary to follow this module.

**MATERIAL CONTENT:**

**Chapter 1** : Introduction to Data Analysis

- General
- Objectives of data analysis
- Overview of methods

**Chapter 2** : Principal Component Analysis

- Objective
- Analysis of individual points i of $N_j(i)$ in $R^P$
- Analysis of individual points j of $N_i(j)$ in $R^n$
- Relationship between points i of $N_j(i)$ and j of $N_i(j)$
- Analysis of additional points
- Principal Component Analysis
-

**Chapter 3** : Simple Correspondence Factor Analysis

- Objective
- Analysis of individual points i of $N_j(i)$ in $R^P$
- Analysis of individual points j of $N_i(j)$ in $R^n$
- Relationship between points i of $N_j(i)$ and j of $N_i(j)$
- Analysis of additional points
- Correspondence Factor Analysis and graphical representations

**Chapter 4** : Multiple Correspondence Analysis

- Complete disjunctive table
- Burt's chart
- Equivalence between the two previous analyzes
- Calculation of contributions in the complete disjunctive table
- Interpreting a Multiple Correspondence Analysis

**Chapter 5** : Classification Methods

- Hierarchical classification

- Classification by partitioning
- Morphological methods

**Chapter 6:** Regression & Correlation

- Descriptive techniques
- Correlation and probabilistic tests
- Exponential smoothing methods

**Chapter 7:** Canonical Analysis

- Definitions
- Methodology
- Properties
- Interpretations

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Stork, DG, Duda, RO, Hart, PE, & Stork, D., *"Pattern classification"* , A Wiley-Interscience Publication, 2001.

2. Bourbonnais, R., and Terraza, M., *"Analysis of time series: Application to economics and management"* , Dunod edition, 2010.

3. Saporta, G., *"Probability Data Analysis and Statistics"* , 3rd edition, Technip, 2011.

4. Hastie, T., & Friedman, J., *"The elements of statistical learning. Data mining, inference and prediction"* , Springer, 2001.

5. Lebart, L., Morineau, A., and Piron, M., *"Multidimensional Exploratory Statistics"* , 4th edition, Sciences Sup, Dunod, 2006.

**Semester: S3**
**Course unit: UET 1.3**
**Subject 1: Technical English 2**
**VHS: 10:30 p.m. (TD: 1:30 a.m.)**
**Credits: 3**
**Coefficient: 1**

**TEACHING OBJECTIVES:**

The objective of this course is to introduce the student to advanced computer science concepts and the techniques of writing articles in English.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basic English and Technical English 1.

**MATERIAL CONTENT:**

**Left**

**UNIT 1. Programming**

- Creating Computer Programs
- Structured and Object-Oriented Programming
- Programming Languages

**UNIT 2. Databases**

- Databases and Database Management Systems
- Database Structures

**UNIT 3. Networks**

- Network Structures
- Network Topologies
- Internet

**UNIT 4. Information Systems**

- IS in the Enterprise
- Development of Information Systems
- Modeling

**Part II**

**UNIT 1.Reading English Scientific Paper**

**UNIT 2. Analyzing English Scientific Paper**

**UNIT 3. Writing English Scientific Paper**

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. English for IT Students, English for Software Engineers / Environmentalists Part II: Textbook. manual for students of institutions. by EA Malashenko, 2014.

2. A Brief Guide to Writing the English Paper, Harvard College Writing Program Faculty of Arts and Sciences Harvard University

## D. Detailed program of Semester 4

**Semester: S4**
**Course unit: UEF 1.4**
**Subject 1: Machine Learning**
**VHS: 90h00 (Course: 03h00, TD: 1h30, TP: 1h30)**
**Credits: 6**
**Rating: 3**

**TEACHING OBJECTIVES:**

This course has two main objectives:

- Understand supervised/unsupervised learning methods and generative models to neural networks.
- Mastery of optimization techniques used in machine learning.

**RECOMMENDED PRIOR KNOWLEDGE:**

Have good mathematical skills, especially in probability and statistics.

**MATERIAL CONTENT:**

This course introduces the foundations of machine learning through 5 chapters.

**Chapter 1: Introduction to Machine Learning**

1.1. Introduction to machine learning
1.2. Fields of application
1.3. Data preprocessing

**Chapter 2: Regression**

2.1. Simple linear regression
2.2. Multiple linear regression
2.3. Polynomial regression
2.4. Support vector regression
2.5. Random-Forest Regression

**Chapter 3: Classification**

3.1. Logistic regression
3.2. K-nearest neighbors
3.3. Support vector machine
3.4. Random drill
3.5. Naive Bayesian model

**Chapter 4: Clustering**

4.1. K-means
4.2. Hierarchical clustering
4.3. Expectation maximization
4.4. Density-based clustering

**Chapter 5: Dimensionality Reduction**

5.1. Principal component analysis
5.2. Independent component analysis
5.3. Adjustments
5.4. Linear discriminant analysis

**Chapter 6:** Introduction to Neural Networks

6.1. Perceptron
6.2. Train the perceptrons
6.3. The phases of a neural network model

**Chapter 7:** Ensemble Methods

7.1. bagging
7.2. boosting
7.3. Gradient-Boosting
7.4. Feature sampling
7.5. stacking

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Murphy, KM, *"Machine Learning"* , MIT Press, 2012.

2. Mohri, M., Rostamizadeh, A., and Talwalkar, A., *"Foundations of Machine Learning"* , MIT Press, 2012.

3. Goodfellow, I., Bengio, Y., and Courville, A., *"Deep Learning"* , MIT Press, 2016.

4. Borwein, JM, and Lewis, AS, *"Convex Analysis and Nonlinear Optimization: Theory and Examples"* , Springer, 2006.

**Semester: S4**
**Course unit: UEF 1.4**
**Subject 2: Formal methods for security.**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credit: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

- Enable students to master the formal techniques used to secure computer systems and networks.
- Understand the importance of cryptographic protocols, the subtlety of their analysis and the use of formal specification and verification methods as an essential solution to ensure security objectives.

**RECOMMENDED PRIOR KNOWLEDGE :**

Basic notions of cryptography and mathematical logic.

**MATERIAL CONTENT :**

**Chapter 1:** Reminder on formal methods

**Chapter 2:** Formalization of security policies

**Chapter 3 :** Reinforcement of security policies by rewriting

**Chapter 4 :** Verification and validation of cryptographic protocols

**Chapter 5 :** Analysis of cryptographic protocols by inference systems

**ASSESSMENT METHOD :** Examination (60%), continuous assessment (40%).

**REFERENCES (books and handouts, websites, etc.):**

1. Milner, R., " *Communication and Concurrency "* , Prentice Hall International Series in Computer Science, 1995.
2. Stirling , C., *" Modal and Temporal Properties of Processes "* . 2001 , Springer,
3. Sui, N. , Mejri, M. and Ben Sta, H., " *FASER (Formal and Automatic Security Enforcement by Rewriting): An algebraic approach "* . Computational Intelligence for Security and Defense Applications (CISDA), 2012.
4. Stallings , W. *" Cryptography and Network Security: Principles and Practice "* , Pearson 7 edition, 2016.
5. Ryan, P., Schneider, S. Goldsmith, M., Lowe , G. and Rosco , B. *" Modelling & Analysis of Security Protocols "* . Addison Wesley Professional, 2000.

**Semester: S4**
**Course unit: UEF 2.4**
**Subject 1: System administration and networks**
**VHS: 45h00 (Course: 1h30, Lab: 1h30)**
**Credit: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**
Learn how to use and administer a network environment, plan network installation and upgrades, and perform computer network monitoring, optimization, and maintenance.

**RECOMMENDED PRIOR KNOWLEDGE:** Basic concepts of computer networks, server operating systems (Windows and Linux).

**MATERIAL CONTENT:**

**Chapter 1:** Introduction to computer network administration

- Definition and purposes
- Typology of computer network administration
- Expectations of a Computer Network Administration
- The roles of a computer network administrator
- IT network administration decision-making levels

**Chapter 2:** Supervision of computer networks

- Models of computer network administration according to OSI
- Models of computer network administration according to TCP/IP
- computer network monitoring software
- computer network administration platforms

**Chapter 3:** Server Administration

- Windows Server 2012 as Primary Domain Controller (PDC)
- Windows Server 2012: Advanced Administration: CSD, DFS and DFSR
- Install and configure a Microsoft Exchange 2013 Mail Server
- Windows Server 2016 as Primary Domain Controller (PDC)
- Administering a Windows Server with PowerShell
- Install network services
- Install and configure a Microsoft Exchange 2016 Mail Server

**Chapter 4:** IP addressing and configuration of network equipment - switches and routers

- How to Install Network Services on Windows Server
- Installing Network Services on Linux
- Installation of a mail server under Linux Server
- Install and Configure CMS

**Chapter 5:** Network Storage and Image Manager Solutions

- IP addressing

- Getting Started with Cisco Packet Tracer and GNS3 - Notions of Routing
- Configuring Cisco Routers - Static Routing, RIP v2 and OSPF

**Chapter 6:** Managing Network Services

- Installation and Configuration of a Software NAS Server: OpenMediaVault
- Installation and Configuration of Image Deployment Software: FOG

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES (** Books and handouts, websites, etc. **):**

1. Dordoigne, J. *"Networks Administer a network under Windows or under Linux".* Eni Editions, 2020.
2. Bouchaudy JF, *"Linux administration"* . Eyrolles, 2011.
3. Rohaut, S. *"Linux master system administration",* Eyrolles. 2017.

**Semester: S4**
**Course unit: UEF 1.4**
**Topic 1: Advanced Cryptography**
**VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)**
**Credit: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

This module aims to introduce the student to the latest trends in cryptography, and thus serve as a rich and solid basis for pursuing advanced research in this interesting and important discipline.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basic notions of cryptography, combined with a master's degree in algorithms and data structures.

**MATERIAL CONTENT:**

**Chapter 1:** Reminders on the basics of cryptography

- Basic Cryptography Primitives
- One-Way Functions
- Pseudo-Random Generators

**Chapter 2:** Cryptanalysis

- Introduction and definitions
- Case Study: The Infineon Attack

**Chapter 3:** Elliptic Curve Cryptography

- Introduction
- 3-party key-exchange
- Short signatures.
- Identity-based encryption

**Chapter 4** : Zero-knowledge proof

- Interactive proofs
- Zero-Knowledge
- Zero-Knowledge non-interactive

**Chapter 5:** secure multiparty computation

- Unconscious Transference
- Secure two-party computation
- Differential Privacy

**Chapter 6:** Modular exponentiation in cryptography

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

## BIBLIOGRAPHIC REFERENCES


1. Boneh, D. and Shoup, V. , *"A Graduate Course in Applied Cryptography",* version 5: https://toc.cryptobook.us/book.pdf , 2020.
2. Ananth, P. and Vaikuntanathan, V. *"Optimal bounded-collusion secure functional encryption". Theory of Cryptography Conference* , Springer, 2019.
3. Ash A., and R. Gross. *"Elliptic tales: curves, counting, and number theory"* , Princeton University Press, 2012.

**Semester: S4**
**Course unit: EMU 1.4**
**Topic 1: Network Security**
**VHS: 45h00 (Course: 1h30, Lab: 1h30)**
**Credit: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

This module allows the student to acquire fundamental notions in the security of networks and mobile networks.

**RECOMMENDED PRIOR KNOWLEDGE:**

Notions in networks, cryptography and security.

**MATERIAL CONTENT:**

**Chapter 1:** Fundamental Mechanisms of Network Security

- Audit, diagnostics and countermeasures
- Firewalls
- Proxies
- VPNs
- Intrusion detection systems
- Some security protocols of the TCP/IP model
    i. Introduction to the TCP/IP protocol stack
    ii. WEP/WPA/WPA2/WPA3
    iii. IPsec: AH and ESP
    iv. IPsec: IKE
    v. SSL/TLS
    vi. SSH

**Chapter 2:** Authentication in networks

- Authentication issues.
- Password authentication (the PAP and CHAP protocols).
- Authentication using a network server.
- Use of cryptographic tools for network authentication:
    i. Authentication by digital certificate (notion of PKI).
    ii. Security of WAN connections: VPN (IPsec).

**Chapter 3:** Email Security

- Mailing Lists
- Distribution of public and private keys
- Privacy, Source Authentication, Message Integrity, Non-repudiation, Proof of Submission, Proof of Delivery, Message Privacy, Anonymity
- PrivacyEnhanced Mail (PEM)
- Secure/Multipurpose Internet Mail Extensions (S/MIME)
- Pretty Good Privacy (PGP)

**Chapter 4** : Coding Techniques for Physical Layer Security

- Introduction: Physical Layer Security
- Error-Free Channels: Shannon Encryption System

- Noisy Channels: Wyner's Wiretap Channel
- Coding for the Gaussein Wiretap Channel

**Chapter 5:** Security in mobile networks

- Security of mobile telecommunications networks
- Security in next-generation mobile networks
- IP mobile network security
- Ad hoc network security
- Key management in ad hoc networks
- Security in wireless sensor networks
- Key management in sensor networks
- Authentication in WIFI networks.

**Chapter 6** : Traffic Modeling and Network Traffic Plan Security

- Threat Models for Internet Protocol Networks
- Internet protocol network traffic plans: defense in depth and breadth
- Security Concepts at the Edge of Internet Protocol Networks
- Core Network Security Concepts

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES (** Books and handouts, websites, etc. **):**


1. Chaouchi . H. , Laurent-Maknavicius . M. , *"Security in wireless and mobile networks",* Hermès / Lavoisier editions, 2007.
2. Stallings. W., *"Cryptography and Network Security"* , seventh edition. 2005
3. Luzzi L., " *Coding Techniques for Physical Layer Security "* , ETIS, 2014.
4. Stewart. JM , Chapple. M., Gibson. D., " *CISSP(Certified Information Systems Security Professional) "* , Official Study Guide, 7th edition, 2015.
5. Sehudet. G., Smith. D. _ J. , " *Router Security StrategiesSecuring IP Network Traffic Planes "* , Cisco Press, 2007.
6. Larrieu. N. , Owezarsky. P. , " *On the use of traffic measurements for the engineering of Internet networks "* , Technique et Science Informatique . 2002.

**Semester: S4**
**Course unit: EMU 1.4**
**Topic 2: Operating System Security**
**VHS: 45h00 (Course: 1h30, Lab: 1h30)**
**Credit: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of the module is to allow the student to master the security of operating systems: the basic concepts, the methods of analysis and evaluation of the security of operating systems (desktop and mobile). The student will learn about issues related to authentication, access control, and control flow integrity.

**RECOMMENDED PRIOR KNOWLEDGE:**

Notions on operating systems and security.

**MATERIAL CONTENT:**

**Chapter 1:** Introduction to Operating System Security

**Chapter 2:** Attacks on Systems

**Chapter 3:** Operating system protection mechanisms

**Chapter 4:** Methods for analyzing and evaluating the security of an operating system.

**Chapter 5:** Recovery and failure recovery methods.

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. Silberschatz. A. , Galvin. P. , Win. G. , *“ Operating System Concepts ”* , John Wiley & Sons, 2012.
2. Tanenbaum. A. , *“ Operating Systems ”* , Pearson, 2008.

**Semester: S4**
**Course unit: EMU 1.4**
**Subject 3: Information Systems Security Audit**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credit: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

This module is an introduction to the theory and applications of formal methods in the field of computer science, it covers the rigorous mathematical specification, modeling and verification of systems.

**RECOMMENDED PRIOR KNOWLEDGE:**

Information coding, Computer security, Information systems, networks.

**MATERIAL CONTENT:**

**Chapter 1.** Introduction to auditing information systems

- Objective of the IS audit
- General principle of IS audit
- Types of IS audits

**Chapter 2.** IS Security

- IS security policy
- Information systems security management
- IS security standards

**Chapter 3.** Information systems security audit approach

- Study of the systems to be audited
- Identification of risks and vulnerabilities
- Audit report

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**

1. MÉ, Ludovic and DESWARTE, Yves, 2006. Security of information systems. Paris: Hermes Science Publications: Lavoisier. ISBN 978-2-7462-1259-6.
2. SALHI, Nejib, 2015. Information system security audit and risk analysis: methodologies: PSC/ISO 27002 and MEHARI. Sl: sn ISBN 978-613-1-55439-1.
3. Yende, Raphael, 2018. INFORMATION SYSTEMS (IT) AUDIT COURSE MATERIAL.

**Semester: S4**
**Course unit: UED 1.4**
**Subject: Biometrics**
**VHS: 10:30 p.m. (Class: 1:30 a.m.)**
**Credit: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

- Understand how a biometric system works.
- Know the different types of biometrics and their accuracy.

**RECOMMENDED PRIOR KNOWLEDGE :**

Basic notions of computer security.

**MATERIAL CONTENT :**

**Chapter 1:** Basics of biometrics

- Why biometrics?
- Operation of authentication technologies
- Advantages of biometrics over traditional authentication systems
- Operation and benefits of biometrics in identification systems
- Accuracy in biometric systems

**Chapter 2:** Types of biometrics

- Fingerprints and hand geometry
- Technical description, characteristics, competing technologies, strengths/weaknesses, deployment
- Facial and voice recognition
- Technical description, characteristics, strengths/weaknesses, deployment
- Scan of the iris and retina
- Technical description, characteristics, strengths/weaknesses, model vascular of the retina, deployment
- Signature recognition and keystroke dynamics

**Chapter 3:** Behavioral and esoteric biometric technologies

- Vein pattern
- Facial thermography
- DNA
- Footprint and dynamics of the foot

**Chapter 4:** Biometrics Issues

- Biometric liveness test
- Biometrics in large-scale systems
- Biometric standards
- Biometric tests and assessment

**Chapter 5:** Privacy, Policy and Legal Concerns Raised by Biometrics

- Biometrics and privacy, legal considerations on use governmental biometrics
- Biometrics and feasibility of a national identity card
- Case studies on physiological, behavioral and multifactorial biometrics in identification systems.

**ASSESSMENT METHOD :** Examination (100%).

**REFERENCES :**

1. Woodward. JD , Orleans. Jr. NM and Higgins PT , " *Biometrics "* , dreamtech, 2003.
2. Nanavathi. S. ,Thieme. M. and Nanavathi R. , " *Biometrics - Identity verification in a network "* , Wiley Eastern, 2002.
3. Chirillo J. and Blaul S. , " *Implementing Biometric Security "* , Wiley Eastern Publications, 2005.
4. Shepherd. J. , " *Biometrics for Network Security "* , Prentice Hall, 2004.

## E. Detailed program of Semester 5

**Semester: S5**
**Course unit: UEF 1.5**
**Topic 1: Software Security**
**VHS: 45h00 (Course: 1h30, Lab: 1h30)**
**Credit: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The primary objective of this course is to train the student in the fundamental techniques of program analysis in terms of security and safety, as well as good programming practices.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basics of security. Good basics in programming, algorithms, and data structures.

**MATERIAL CONTENT:**

**Chapter 1:** Introduction to software security and safety.

**Chapter 2:** Classic Attacks Review

- Buffer overflow
- Integraloverflow
- String vulnerabilities
- Other vulnerabilities

**Chapter 3:** Designing Secure Software

**Chapter 4:** Code Analysis

- Static analysis
- Symbolic execution
- Checking models
- Fuzzing

**Chapter 5:** Runtime Protection

- Dynamic taint tracking
- Run-time enforcement

**Chapter 6:** Secure software architectures.

- Introduction
- Separation andVMs
- Memory Protection
- Web defenses
- Trusted Computing

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES**

1. John Musa. D., *"Software Reliability Engineering"* , Tata McGraw-Hill, 2005.
2. Jürjens. J., *"Secure Systems Development with UML"* , Springer , 2004.
3. J. Viega and G. McGraw, "Building Secure Software: How to avoid security problems the right way", Addison-Wesley, 2001.
4. Blokdyk., G., *"Software Security Vulnerability A Complete Guide"* , 5STARCooks, 2020.

**Semester: S5**
**Course unit: UEF 1.5**
**Topic 2: Infrastructure Security**
**VHS: 67h30 (Course: 1h30, TD: 1h30, TP: 1h30)**
**Credit: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

Explain the main security risks and the various existing solutions to secure the Cloud and the Internet of Things.

Study blockchain techniques allowing the learning of techniques for storing and transmitting information, grouped in "chains of blocks" without a control body, with a high degree of security. Investigate blockchain security through decryption methods and transmission protocols.

**RECOMMENDED PRIOR KNOWLEDGE:**

The basic notions of IT security and Cloud Computing.

Computer security, encryption techniques, authentication protocols and distributed systems.

**MATERIAL CONTENT:**

**Part 1 Cloud Security**

**Chapter 1:** Vulnerabilities in the Cloud

**Chapter 2:** Cloud Security

**Part 2 security in the IoT**

**Chapter 3:** Internet of Things (IoT)

**Chapter 4:** Vulnerabilities in the Internet of Things

**Chapter 5:** Security in the Internet of Things

**Part 3 security and blockchains**

**Chapter 2:** Fundamental Blockchain Concepts
**Chapter 3:** Security and Reliability and Blockchain

**Chapter 5:** Architecture of blockchain-based applications

**ASSESSMENT METHOD:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES**

1. And he welcomed it. H., FetjahL., Sekkaki. A. , " *State of the Art of Security in Cloud Computing Security Issues and Solutions ",* Cloud Computing.Conference, 2012.
2. winkler. V., *"Security in the Cloud Techniques for secure cloud computing",* Eyrolles, 2011.
3. Pearson. S., Yee. G., *"Privacy and Security for Cloud Computing",* Springer, 2013.

4. Croman, K., Decker, C., et al., *"Scaling Decentralized Blockchains"* , FC International Workshops, 2016.

5. Xu, X., Weber, I., Staples, M., *"Architecture for Blockchain Applications"* , Springer 2019.

6. Gates, M., *"Blockchain ultimate guide to understanding blockchain, bitcoin, cryptocurrencies, smart contacts and the future of money"* , Kindle Edition, 2017.

7. Laurence, T., *"Blockchain For Dummies"* , John Wiley & Sons, 2017.

**Semester: S5**
**Course unit: UEF 2.5**
**Topic 1: Trust Management**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credit: 5**
**Rating: 3**

**TEACHING OBJECTIVES:**

This course aims to explain the importance of trust as a central element of the issue of security in computer and information systems.

**RECOMMENDED PRIOR KNOWLEDGE:**

Basics of security. Networks.

**MATERIAL CONTENT:**

**Chapter 1:** Trust Basics

- Definitions.
- Sociological and technical aspect.
- Trust at the heart of security.
- Property of trust.

**Chapter 2:** Trust Management

- Authentication and identification mechanisms.
- Overview of Public Key Infrastructure (PKI), Entities.
- Conceptual standards and challenges.
- Implementation and deployment.
- Trust management challenges.

**Chapter 3:** Trust and social networks

- Overview of social networks.
- Importance of trust.
- Social capital and trust.
- Information Collection.
- Trust assessment and prediction.

**Chapter 4:** Attacks on Trust

- Attack classification criteria.
- Examples and effects on the evaluation of trust.

**Chapter 5:** Trust in the Internet of Things

- The importance of trust in the IoT.
- Trust models and frameworks in the IoT.

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES**

1. Bertino. E., Matei SA, *" Roles, Trust, and Reputation in Social Media Knowledge Markets: Theory and Methods "* , Springer , 2015
2. Boswarthick. D., Hersent. O., and Elloumi. O., " *The Internet of Things: Key Applications and Protocols "* , John Wiley & Sons , 2011.

**Semester: S5**
**Course unit: UEF 2.5**
**Subject 2: Technique of intrusion and defense**
**VHS: 45h00 (Course: 1h30, Lab: 1h30)**
**Credit: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The purpose of this module is to introduce the student to techniques for preventing computer attacks by strengthening technical, organic and operational cooperation; The student must be able to manage a crisis linked to a cyber attack.

**PRIOR KNOWLEDGE RECOMMENDED**

Know the basics of security

**MATERIAL CONTENT:**

**Chapter 1** : Introduction to intrusion detection.

**Chapter 2** : Intrusion Detection Methods

- Detection of an attack exploiting an unknown vulnerability: behavioral approach
- Detection of an attack exploiting a known vulnerability: scenario-based approach

**Chapter 3** : Perimeter Defense

- Network filtering
- Email filtering
- Web access filtering

**Chapter 4** : Defense in Depth

- Internal partitioning
- Anti-virus
- HIPS (Host Intrusion Prevention System)
- VPM (Vulnerability and Patch Management)
- Hardening
- NAC (Network Access Control)
- Data encryption (stored)
- VPN (Virtual Private Network)
- Flow security: TLS, IPSEC

**Chapter 5** : Intrusion Detection Tools

**Chapter 6:** Physical attacks and anti-tampering solutions

**Chapter 7:** Physical Trojan Horse: Detection and Design of Trusted Integrated Circuits

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES**

1. Me. L., Alonou. V., " *Intrusion detection in a computer system: methods and tools "* , Supelec BP 1996.

2. Sabahi. F., and Movaghar. A., " *Intrusion detection: A survey".* Third International Conference on Systems and Networks Communications, 2008.
3. Pathan, AK, *"The state of the art in intrusion prevention and detection"* , CRC press, 2014.
4. Tehranipoor, M., and Wang, C., *"Introduction to hardware security and trust"* , Springer Science & Business Media, 2011.
5. Bhunia. S., Hsiao. M. Banga. M., Narasimhan. S., *" Hardware Trojan attacks: threat analysis and countermeasures "* . proc. IEEE, 2014.
6. Sklavos, N., Chaves, R., Di Natale, G., et al. *"Hardware security and trust"* , Springer, 2017.

**Semester: S5**
**Course unit: EMU 1.5**
**Topic 1: Data Anonymization**
**VHS: 45h00 (Class: 1h30, TD: 1h30)**
**Credit: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

Study of risks related to data security on the Internet, in order to minimize and control digital traces and personal data. Learn about privacy technologies.

**RECOMMENDED PRIOR KNOWLEDGE:** Basic concepts of computer security, web data management, web technologies.

**MATERIAL CONTENT:**

**Chapter 1:** Issues of privacy protection

**Chapter 2:** Privacy on the Internet

**Chapter 3:** Data Attack Model

**Chapter 4 :** Privacy Models

**Chapter 5 :** Data Anonymization Techniques

**Chapter 6:** Legal Privacy Laws

**METHOD OF ASSESSMENT:** Examination (60%), continuous assessment (40%).

**BIBLIOGRAPHIC REFERENCES:**


1. Collard. F., et al., " *Computing and private life"* , Éditions Labor, 1980.
2. Untersinger. M., " *Anonymity on the internet - Understanding to protect your privacy"* , Eyrolles, 2013.
3. Roy. Y., *"Internet technology and privacy"* , Dunod, 2014.
4. John David. D., *"Everything you need to know to protect your privacy on the Internet"* , Editions Eyrolles, 2014.
5. Gambs. S., *"Protection of privacy in social networks"* , Institute for Research in Computer Science and Random Systems, 2015.

**Semester: S5**
**Course unit: EMU 1.5**
**Topic 2: Ethical Hacking**
**VHS: 67h30 (Course: 1h30, Lab: 3h)**
**Credit: 4**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

- Understand the basics of ethical hacking.
- Learn to attack to better defend yourself.
- Learn the basics of network security and penetration testing.
- Prepare for jobs or studies in the field of cybersecurity.

Practical work to create a test laboratory and practice *legally* in compliance with the laws and ethics of hacking accompany the theoretical training of this module.

**RECOMMENDED PRIOR KNOWLEDGE :**

Basic notions of the different fields of IT; security, network administration, web technologies, operating systems and system programming.

**MATERIAL CONTENT :**

**Chapter 1:** Introduction to Ethical Hacking

- Concept of ethical hacking and reach
- Implementation of a security policy
- Incident management and vulnerability assessment
- Information security laws, standards and regulations
- Sanctions against piracy
- Security of personal data

**Chapter 2:** Recognition

- Gathering information and identifying faults
- Various techniques: Footprinting, Scanning & Enumeration

**Chapter 3:** Hacking Systems

- Intrusion and escalation of privileges
- Tools and apps to ensure access
- Exploitation and recovery of traces
- Countermeasures and means of prevention

**C hapter 4:** Studying Malware

- Operation and detection of malware

- Interactions with the operating system
- Introduction to forensic analysis

**Chapter 5:** Social Engineering

- Concept of the human flaw
- Typology of attacks (human, computer & mobile-based)
- Countermeasures and means of protection

**Chapter 6:** Physical Access Vulnerabilities

- Different physical flaws (direct access to the machine)

**C hapter 7:** Network faults

- Denied service
- Session theft
- Sniffing
- Man In The Middle (MITM)
- Wi-Fi flaws (notions of WEP, WPA and WPS)

**ASSESSMENT METHOD :** Examination (60%), continuous assessment (40%).

**REFERENCES :**

1. Ebel. F. , Baudru. SB , Croffer. Ro. , " *Computer Security Ethical Hacking, Learn the attack to better defend yourself "* , Editions ENI, 2017.
2. Rascagneres. P. , " *Computer Security and Malware, Threat Analysis and Implementation of Countermeasures "* , Editions ENI, 2019.
3. Theme. J. , " *Computer Security on the Web, Learn how to secure your applications "* , Editions ENI, 2017.

**Semester: S5**
**Course unit: UED 1.5**
**Topic 1: Security policies and legal aspects**
**VHS: 10:30 p.m. (Class: 1:30 a.m.)**
**Credit: 3**
**Coefficient: 2**

**TEACHING OBJECTIVES:**

The objective of this subject is to familiarize the student with the rights of the security policy of information systems and the pedagogy that must be applied to the security of information systems.

**PRIOR KNOWLEDGE RECOMMENDED**

Know the basics of security

**MATERIAL CONTENT:**

**Chapter 1:** Security Policy

I.1. Definition of a security policy

I.2. Implementation of a security policy

I.3. Validation of a security policy

I.4. Business Continuity Management

I.5. Formalization of security policies

**Chapter 2:** Legal Aspects of Cybersecurity

II.1. Protection of personal data

- Presentation of the legal framework
- The Data Protection Act
- Design and management principles

II.2 Criminal aspects

- "computer hacking"
- Research and disclosure of vulnerabilities
- Computers as a tool to commit other crimes
- Actors in legal proceedings

**Chapter 3:** ISO/IEC 27032 standard for cybersecurity

III.1 Introduction to standardization in cyber-security

III.2 Actors and resources in cyberspace

III.3 Threats to cyberspace security

III.4 Administration of cyber-security

**ASSESSMENT MODE:** Exam (100%).

**BIBLIOGRAPHIC REFERENCES**

1. Thomas R.P. , Justin P. , John B. , *“ Information Security Fundamentals ”* , CRC Press, LLC, 2005.
2. Richard. W. _ , Stephen. F. _ , “ *Legal aspects of cybersecurity ”* , Action Canada-France, 2016.
3. Papini. O., “ *Information Systems Security (Security Policy)”* , ESIL University of the Mediterranean, 2013 .
4. Piole. G., *“Legal aspects of IT”* , ENS Académie de Rennes, 2013.

## F. Detailed program of Semester 6

**Period: S6**
**Course unit: Directed Training**
**Subject: End of Cycle Project (Personal Work)**
**HV: 600h**
**Credits: 30**
**Rating: 15**

## TEACHING OBJECTIVES:

After the industrial internship, the students know the company better, gain confidence in their skills and have a more exact idea of their professional objectives.

The lessons must allow students to be entrusted with personal, individual or collective work in the form of tutored projects that may concern all the disciplines covered.

These projects will be the subject of complete subjects to be carried out if possible in liaison with the industrial environment.

## PROGRAM :

Choice of the subject ;

Documentation search;

Analysis of existing technical solutions;

Implementation of hardware and software components;

Sizing and Simulation;

Validation of technical solutions;

Dissertation writing associated with the subject.

## AUTONOMOUS WORK :

Individual work and writing a dissertation.

## EVALUATION METHOD:

- Scientific value (Assessment of the jury) /6
- Dissertation writing (Jury assessment) /5
- Presentation and answer to questions (Assessment of the jury) /5
- Appreciation of the supervisor /4

# IV– Agreements / Conventions

# V - Opinions and Visas of the Administrative and Advisory Bodies

# Opinions and visas of administrative and advisory bodies

**Course title** : IT
**Title of specialty** : Cybersecurity

| Deputy Director of Studies |
| --- |
| Date and stamp:  |
| **President of the Scientific Council** |
| Date and stamp:  |
| **Headmaster** |
| Date and stamp:  |