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**	**Artificial Intelligence and Data Science**

Head of the training area team: KACIMI Farid

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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	الذكاء الاصطناعي وعلوم البيانات

مسؤول فرقة ميدان التكوين :قاسيمي فريد

Summary	Page

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 Farid KACIMI

Tel : (213) (0)773707006 **E-mail:** kacimi@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:

- Abderrahmane 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 (C EVITAL , Soummame Dairy , DANONE Djurdjura Algeria, 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

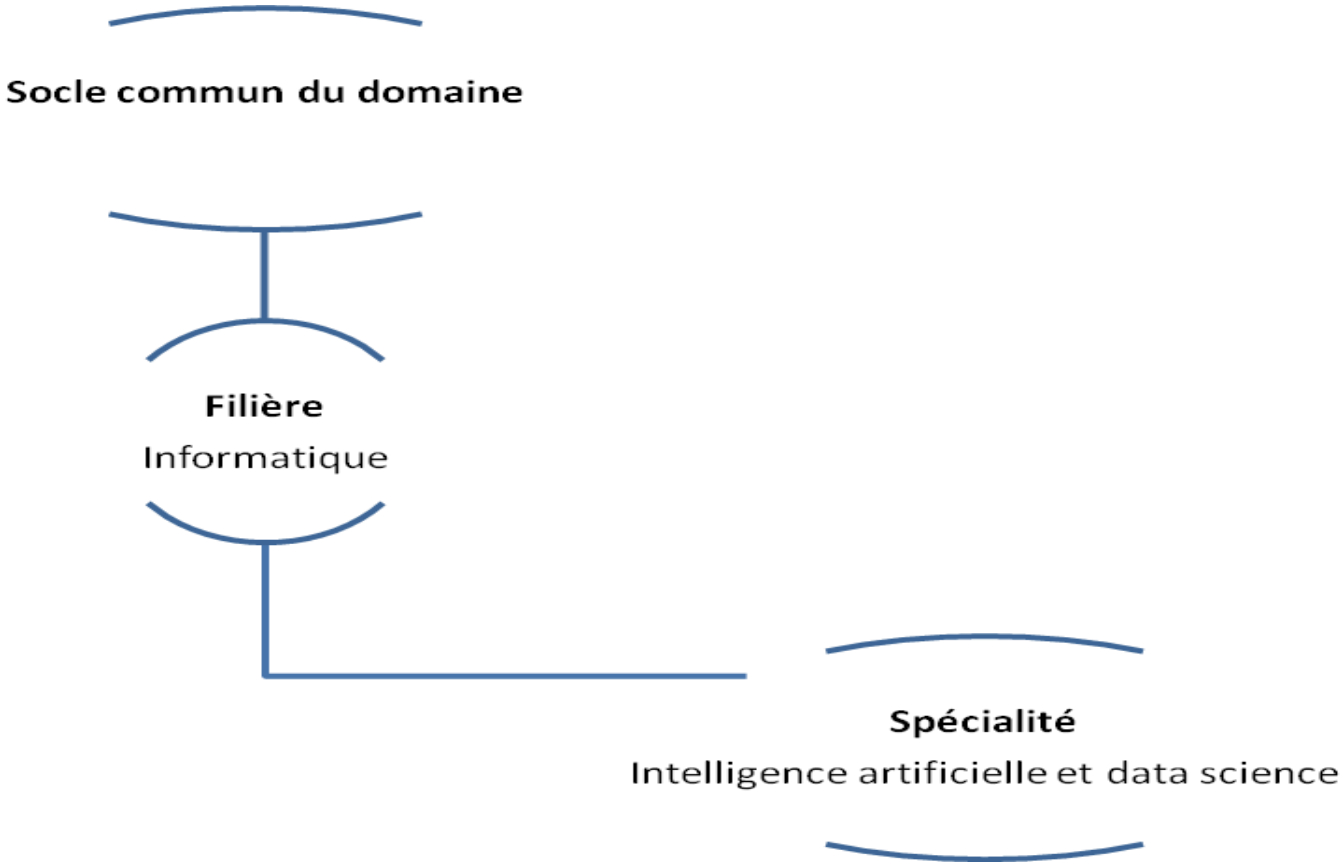
A – Position of the project

Title of the course:

IT ENGINEER

Title of specialty:

Artificial Intelligence and Data Science


Socle commun du domaine
Filière
Informatique
Spécialité
Intelligence artificielle et data science

B - Training objectives

Skills in Artificial Intelligence (AI) and Data Science (DS) are increasingly sought after, particularly in the fields of digital, industry, marketing, finance, health, transport, environment , etc. The notable increase in job offers in these fields is a good illustration of this enthusiasm, making AI and DS an undeniably buoyant sector.

The Graduate School of Computer and Digital Sciences and Technologies (ESTIN) will train multidisciplinary skills capable of storing, extracting, analyzing and exploiting large volumes of data for multiple professional/academic objectives: decision support, evaluation , optimization, prediction, etc.

The training course is part of the context of our country's digital transformation process. It is made up of five years of study. Two years of preparatory classes that will allow students to acquire solid knowledge in mathematics and computer science, a year of common core including lessons on the foundations of artificial intelligence, Big Data, emerging digital technologies , etc. Finally, two years of specialization in Artificial Intelligence and Data Science. The training ends with an end-of-cycle internship lasting six months in targeted companies.

Following a course in AI and DS, the student engineer could embark on one of the following professions:

- Digitization project manager
- Big Data project manager
- Analytics consultant
- Data Designer
- Data Engineer
- data scientist
- Big Data Developer
- AI engineer
- Etc.

C. Profiles and skills targeted

The main objective of this course is to enable future engineering students to acquire knowledge in Digital Sciences (Artificial Intelligence and Data Science) to implement solutions adapted to the job market in targeted areas.

The few professions targeted in the short and medium term by this training are described in the following table:

Targeted business areas	Benefits in terms of skills
1. Public health	- Digitize the patient file and the hospital information system (Smart Healthcare); - Predict health crisis situations by using machine learning techniques; - Implement medical diagnostic support systems; - Develop new methods of medical imaging and telemedicine .
2. Industrial sector	- Digitize business processes in the industrial sector for intelligent decision-making (Smart Decision Making); - Perform predictive maintenance; - Develop intelligent Robots and Automatons; - Develop intelligent systems such as SCADA to improve the production process.
3. economic enterprise	- Digitize the business processes of companies; - Use AI to help better target customers; - Analyze large volumes of customer related data to understand market trends.
4. Finance (banking and insurance)	- Digitize financial flows; - Assess risks using AI; - Detect fraud by using learning machine; - Optimize offers/customer relations.
5. e-governance	- Digitize the business processes of public administration (local authorities, judicial institution, education, professional training, defence, security services, etc.); - Support the public administration to offer digital services to citizens; - Implement intelligent decision support systems for public administration;

D – Regional and national employability potential

Activity area :

The training of student-engineers in AI and DS meets the extremely strong demand in terms of skills in the various fields related to emerging digital technologies, Artificial Intelligence and Data Science. This training will allow student-engineers to access the highest level of academic knowledge in the field of IA & DS, in terms of research but also in a dimension of professional

integration. In addition to training in fundamental and/or applied research through immersion in research entities in Algeria, this specialty also aims to enable student engineers to integrate into large companies, such as SONATRACH, CEVITAL, Algérie TÉLÉCOM, etc or support them in the creation of their own businesses within the framework of the Entrepreneurship house.

Regional and national contexts of professional integration:

- National industrial fabric (public and private)
- National companies (public and private)
- Educational institutions and scientific research entities
- Public administration (local authorities, judicial institution, education, vocational training, defence, security services, etc.)
- Banks
- Health establishments (public and private)

E. General organization of the training

The educational path:

The duration of training leading to the Engineer's degree is six semesters consisting of supervised training (2002h30) and a directed training (2015h30) totaling 4018h00 or 180 credits.

Supervised training					
Teaching unit	**Number of Modules**	**Hourly volume**	**Credit**	**% in credits for each teaching unit**	**Total**
Fundamental EU	20	12:37 p.m.	91	61.80%	**39** mods **2002:30**
Methodological Unit	14	652h30	44	32.58%	
EU Discovery	3	67:30	9	3.37%	
Transversal UE	2	45:00	6	2.25%	

Hours	S1	S2	S3	S4	S5	Total	
Course	180h	180h	3:30 p.m.	8:30 p.m.	3:30 p.m.	877h30	43.82%
TD	3:30 p.m.	3:30 p.m.	1:00 p.m.	90:00	67:30	630h00	31.46%
TP	90 hours	67:30	90:00	1:00 p.m.	1:00 p.m.	495h00	24.72%
Total	**427h30**	**405 hours**	**382h30**	**427h30**	**360h00**	**2002 h30**	**100%**

Directed Training			
Nature	**Hourly volume**		**Total**
Personal work	3:48 p.m.	76.81%	**2015h30**
Visit of industrial	67:30	3.35%	

sites		
Internship	250 hours	12.40%
EFP	100 hours	4.96%
Seminars and workshops	50 hours	2.48%

The **supervised training** is made up of 39 modules, ie 2002 hours and 30 minutes.

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 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:

- Semester knowledge check
- Oral exam
- Seminars and workshops
- Evaluation of internship reports
- Assessment of personal work

F – Performance indicators expected from the training

All training must meet quality assurance requirements. As such, to better assess the expected performance of the IA/DS training, a certain number of mechanisms are proposed to evaluate and monitor the progress of the lessons, the training programs, the student/teacher and student/administration relations, the employability of graduates as well as the assessments of the economic partners as to the quality of the graduates recruited and/or the teaching provided.

The evaluation methods can be concretized by surveys, follow-up of students in training and surveys of students in professional integration.

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

Evaluation of the course of the training:

In addition to the ordinary meetings of the pedagogical committee, an evaluation of the lessons by the students is carried out every six months. It will involve teachers and students from the different promotions in order to discuss any problems encountered, possible improvements to be made to teaching methods in particular and to training in general.

The school will appoint a student mediator teacher who will be responsible for providing teacher/student mediation to solve critical or urgent problems that may arise.

To this end, a more or less exhaustive list of the indicators and methods envisaged for the evaluation and monitoring of this training by the educational committee is proposed below:

Prior to training:

- Number of students who chose 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.

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.

After training:

- Number and success rate of students enrolled in this option.
- Rewarding and encouraging the best students.
- Number and dropout rate (failures and dropouts) of students enrolled in this option.
- 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 diplomas 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 educational laboratories and centers Calculation.

- Existence of anti-virus software and educational software at the level of educational laboratories and computing center.
- IT maintenance contracts with suppliers.
- Training of technical staff on computer resources and teaching materials.
- Existence of a digital teaching platform in which lessons, 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 related to the field of AI and data sciences.
- Rate of use of books, available in the institution's library, related to the AI and data sciences 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:

- Create 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 initiate 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:

In the long term, a commission will be set up to get feedback on the professional integration of graduates. Here is the non-exhaustive list of indicators that will be supported:

- Recruitment rate of graduates in a position directly related to training.
- Possibility of recruitment in different sectors in relation with DS/IA.
- Recruitment of graduates in sectors indirectly related to the field of AI and data sciences.

- Nature of jobs held by students at the end of their studies (Diversity of opportunities)
- Number and rate of students graduating from this training holding positions of responsibility in companies.
- Degree of adaptation of the graduate recruited in the working environment.
- Success of school graduates 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 professionals in the specialty:

The school's graduate professional integration evaluation committee will draw up a detailed report on the feedback on the quality of this training, which will be used by management to make relevant changes to the program. Indicators to consider include:

- Degree of satisfaction of potential employers.
- Employer interest in DS/IA 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.

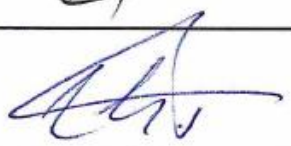
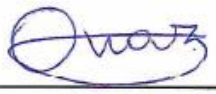
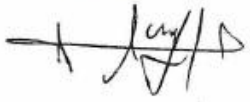
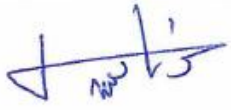
4 – Human resources available

A - Supervisory capacity

Supervision capacity : 100 students

B - Pedagogical team mobilized for the specialty

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	

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
KECHADI M. Tahar (UCD Dublin)	Prof.	Artificial Intelligence, Data Mining, Big Data, Distributed Systems, Digital Forensics	End of cycle seminar Doctoral studies
AHMED NACER Mohamed (USTHB)	Prof.	Software engineering	Software engineering Doctoral studies
AIT AMEUR Yamine (ENSEHIT, Toulouse, France)	Prof.	Formal Methods	End of cycle seminar Doctoral studies
ALILI Mohamed (University of Quebec in Outaouais)	Prof.	AI, Machine Learning	End of cycle seminar Doctoral studies
SAIS Lakhdar (Artois University, France)	Prof.	Complexity, Advanced Algorithms	End of cycle seminar Doctoral studies
AMIRAT Yacine (Paris-Est University, France)	Prof.	AI, Reasoning, Fuzzy logic	End-of-cycle seminar Doctoral training
BOUFAIDA Mahmoud (University of Constantine 2)	Prof.	semantic web	End-of-cycle seminar Doctoral training
KHEDDOUCI Hamamache (University of Lyon 1, France)	Prof.	Big Data, Graphs, Semantic Networks	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	End-of-cycle seminar Doctoral training
DJOUDI Mahieddine (University of Poitiers , France)	Dr/HDR	Digitization of education systems	Digitization technologies in organizations Doctoral studies
BELLATRECHE Ladjel (ENSMA, Poitiers)	Prof.	Big Data, Distributed Databases, Ontologies	End-of-cycle seminar Doctoral training
BOUABDELLAH Abdelmadjid (UTC of Compiègne, France)	Prof.	Advanced networks	Networks 2 Doctoral studies
Ahcene Bouncer (UBO, France)	Dr/HDR	Mobile networks	End-of-cycle seminar Doctoral training

D - Overall summary of human resources mobilized for the specialty

Grade	Internal workforce	External Workforce	Total
Teachers	03	12	**15**
Lecturers (A)	04	01	**07**
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	**39**	**10**	**49**

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 the Abderrahmane MIRA University of 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 - 02 amphitheatres with a capacity of 400 seats - 06 amphitheatres with a capacity of 300 seats

	- 25 tutorial rooms with 40 places - 29 practical work rooms with 20 places - 01 conference room with a capacity of 180 seats - 01 Auditorium with a capacity of 500 seats
Laboratories/projects/training support research teams	- Laboratory of Computing and Advanced Digital Technologies (LITAN). Under approval. - Laboratory of Medical Informatics (UAM of Béjaia)
Library	- Central reading room with a capacity of 700 seats - internet room

In addition, infrastructure sharing is planned with Abderrahmane MIRA University in Béjaia .

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

Semester 1 : 1st year of the second cycle (common semester with the Cyber-security 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	67:30	30:00	40%	60%
	Random Processes and Queues	3	2	1h30	1h30		45:00	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.**	**06h 0 0**	**427h30**	**307:30**		

Semester 2: 1st year of the second cycle (joint semester with the Cyber-security 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 a.m. _ _ _**	**405h00**	**292h30**		

Semester 3: 2nd year of the second cycle (joint semester with the Cyber-security 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%
	Conduct project	3	2	1h30		1h30	45:00	30:00	40%	60%
	Data analysis	3	2	1h30	1h30		45:00	32:30	40%	60%
Discovery Teaching Unit 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 second cycle , Option: Artificial Intelligence and Data Science

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 : 9 Coefficients: 5	Machine Learning	6	3	3:00	1h30	1h30	90:00	60:00	40%	60%
	Data Warehouse and Big Data	3	2	1h30		1h30	45:00	30:00	40%	60%
Fundamental EU Code: UEF 2.4 Credits: 9 Coefficients: 5	Distributed databases	4	2	1h30	1h30	1h30	67:30	45:00	40%	60%
	Knowledge Engineering	5	3	1h30	1h30	1h30	67:30	45:00	40%	60%
Methodological Unit Code: EMU 1.4 Credits: 9 Coefficients: 6	Advanced statistics	3	2	1h30	1h30		45:00	30:00	40%	60%
	Image processing base	3	2	1h30		1h30	45:00	30:00	40%	60%
	Time series	3	2	1h30		1h30	45:00	30:00	40%	60%
Discovery Teaching Unit Code: UED 1.4 Credits: 3 Coefficients: 1	Digital technologies in organizations	3	1	1h30			10:30 p.m.	45:00		100%
Total semester 4		**30**	**1 7**	**1:30 p.m.**	**6:00 am**	**09:00 _ _ _**	**427h30**	**315:00**		

Semester 5: 3rd year of the second cycle , Option: Artificial intelligence and data science

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: 1 0 Coefficients: 6	deep learning	5	3	1h30	1h30	1h30	67:30	55:00	40%	60%
	Reinforcement learning	5	3	1h30	1h30	1h30	67:30	60:00	40%	60%
Fundamental EU Code: UEF 2.5 Credits: 9 Coefficients: 5	Pattern recognition for image analysis	5	3	1h30	1h30	1h30	67:30	55:00	40%	60%
	Automatic language processing	4	2	1h30		1h30	45:00	30:00	40%	60%
Methodological Unit Code: EMU 1.5 Credits: 8 Coefficients: 4	business intelligence	4	2	1h30		1h30	45:00	30:00	40%	60%
	NoSQL databases	4	2	1h30		1h30	45:00	30:00	40%	60%
Discovery Teaching Unit Code: UED 1.5 Credits: 3 Factors 1	Ethics in AI	3	1	1h30			10:30 p.m.	30:00		100%
Total semester 5		**30**	**1 6**	**10:30 a.m.**	**04:30 a.m. _ _ _**	**09:00 _ _ _**	**360h00**	**290h00**		

Semester 6 : 2nd year of second cycle , Option: Artificial intelligence and data science

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, Lab: 1h30)
Credits: 5
Rating: 3

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 .
    - Shortest Remaining Time Algorithm 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 .

ASSESSMENT METHOD: 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, Simulator Packet trace, routing)

EVALUATION METHOD:

Examination (60%), continuous monitoring (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. Toutain , 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",* After , 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 UML modeling language (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
2.2.3 Some properties
2.2.4 Necessary conditions of acyclicity
2.3 Connectedness and strong connectedness
2.3.1 Connectedness
2.3.1.1 Definitions
2.3.1.2 Necessary condition of connectivity
2.3.1.3 Search algorithm for connected components
2.3.1.4 Isthmuses and hinge points
2.3.1.5 Distance, diameter
2.3.2 Strong connectedness
2.3.1.1 Definitions
2.3.1.2 Strongly connected components and the reduced graph
2.3.1.3 Search algorithm for strongly connected components
2.4 Remarkable pathways
2.4.1 Eulerian pathways
Hamiltonian paths
2.3 Some interesting algorithms
2.3.1 Algorithm for obtaining the transitive closure of a graph
2.3.2 Algorithm for testing the absence of a circuit
2.3.3 Algorithm for obtaining a circuit
2.3.4 Algorithm for obtaining the levels of a graph without a circuit

Chapter 3. Coloring and coupling
3.1. Vertex coloring
3.1.1. Definitions
3.1.2. Welsh -Powell coloring algorithm
3.1.3. Bounds for the chromatic number
3.2. Coupling
3.2.1. Definitions
3.2.2 Maximum coupling problem
3.2.3 Characterization of a maximum coupling
3.2.4 Algorithm for obtaining maximum coupling in a bipartite graph
3.3. Edge coloring
3.3.1. Definitions
3.3.2. Edge coloring algorithm

Chapter 4. Trees
4.1 Cycles and co-cycles
4.1.1 Definitions and essential properties of cycles and cocycles
4.1.2 Cyclomatic number , cocyclomatic number
4.1.3 Base of cycles, base of cocycles
4.1.4 Vector subspaces of flows and tensions
4.2 Trees and Trees
4.2.1 Properties of trees
4.2.2 Minimum weight tree problem
Kruskal 's algorithm
4.2.2.2 Prim 's algorithm
4.2.3 Properties of trees
4.2.4 Minimum weight tree

Chapter 5. Shortest Path

5.1 Definitions and position of the problem
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.

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

Semester: S 1
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

6.3.6 Generating from frequently used distributions
6.4 Simulation of a discrete-time Markov chain
6.5 Discrete Event Simulation (Queue Simulation)

ASSESSMENT METHOD: 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

ASSESSMENT METHOD: 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.

B. 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

ASSESSMENT METHOD: 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, Lab: 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.

ASSESSMENT METHOD: 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 issues 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

ASSESSMENT METHOD: 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
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: UEM 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

ASSESSMENT METHOD: Examination (60%), continuous assessment (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: UEM 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, T1 numerical analysis"* , 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 .

C. 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, Lab: 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
- 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

ASSESSMENT METHOD: 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 language .
- NoSQL databases .

RECOMMENDED PRIOR KNOWLEDGE:

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

MATERIAL CONTENT:

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"* , Editions ENI; 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: EMU 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

ASSESSMENT METHOD: 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. (Class: 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 E. A. 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: Methods overall

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

ASSESSMENT METHOD: 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: Data Warehouse and Big Data
VHS: 45h (Course: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

Enable students to understand the principles of data warehouses and Big Data.

RECOMMENDED PRIOR KNOWLEDGE:

Knowledge of relational and advanced databases, and mathematical formalisms are necessary to follow this module.

MATERIAL CONTENT:

Chapter 1. Data Warehouses and Data Marts.
- Definitions
- Objectives of a Data warehouse
- Architecture of a Data warehouse
- Development of a data warehouse

Chapter 2. Multidimensional modeling.
- Multidimensional modeling
- From table to cube
- Implementation strategies
- Star, snowflake and constellation diagram

Chapter 3 . Feeding a Data Warehouse
- General process of powering an ED
- ETL processes and tools
- Tasks of an ETL process

Chapter 4 Operation of a Data warehouse
- OLAP, OLAP versus OLTP
- Basic OLAP operations and languages for OLAP
- Realization of various reports *(Reporting)*
- Realization of dashboards from an ED *(Dashboards)*
- Visualizations around an ED

Chapter 5: Introduction to Big Data
- Characteristics of Big Data
- Different types of data
- Data acquisition
- Governance and performance requirements

Chapter 6. Big Data Storage Concepts
- Clusters
- Filesystems and Distributed Filesystems

- NoSQL
- Share
- Replication
- CAP and ACID theorem

Chapter 7. Big data processing concepts

- Parallel data processing
- Distributed data processing
- Hadoop
- Processing workloads
- Cluster
- Batch mode processing
- Real-time mode processing

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

BIBLIOGRAPHIC REFERENCES :

1. Krishnan, K., *"Data warehousing in the age of big data"* , Newnes , 2013, ISBN 978-0-12-405891-0

2. Agosta , L., & Agosta , L., *"The essential guide to data warehousing"* , Upper Saddle River: Prentice Hall PTR, 2000.

Semester: S4
Course unit: UEF 2.4
Topic 1: Distributed Databases
VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)
Credits: 4
Coefficient: 2

TEACHING OBJECTIVES:

Understand, use and develop advanced technologies to manage, optimize and secure centralized and distributed databases.

RECOMMENDED PRIOR KNOWLEDGE:

Knowledge of relational databases, the notion of functional dependency and normal forms.

MATERIAL CONTENT:

Chapter 1: Complex Data Types

1. Semi-structured data,
2. Spatial Data,
3. Temporal Data,
4. Multimedia data.

Chapter 2: Data Distribution Design

1. Design alternatives
2. Fragmentation,
3. Distribution Transparency
4. Impact of distribution on user queries

Chapter 3: Query Optimization

1. Processing of queries in centralized systems
2. Query processing in distributed systems

Chapter 4: Transaction Management

1. Terminology
2. Multi-transaction processing systems
3. Concurrency control in centralized systems
4. Concurrency control in distributed systems

Chapter 5: Security Management in Databases

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

BIBLIOGRAPHIC REFERENCES:

1. Gardarin , G., Valduriez P., *"Advanced DBMS, Object, deductive and distributed databases"* , Eyrolles , 1990.

2. Ozsu , T., Valduriez , P., " *Principles of Distributed Database Systems"* , Vol . 2, Ed., Englewood Cliffs: Prentice Hall, 1999.

3. Gardarin , G., *"Object and relational databases"* , Edition Eyrolles , 1999.

4. Marcenac , P., *"Relational DBMS: performance optimization"* , Editions Eyrolles , 1993.

Semester: S4
Course unit: UEF 2.4
Subject 2: Knowledge Engineering
VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)
Credits: 5
Rating: 3

TEACHING OBJECTIVES:

Master the formalisms of knowledge representation in a certain, uncertain, vague, ambiguous, incomplete or vague framework.

RECOMMENDED PRIOR KNOWLEDGE:

Knowledge of mathematics, logic, basics and a mastery of programming are necessary to follow this module.

MATERIAL CONTENT:

Chapter 1: Basics of Classical Logic

1. logic of the proposals,
2. Predicate logic,
3. Representation of knowledge by these logics.

Chapter 2: Concept of modality

1. Syntax,
2. Deduction rules,
3. Presentation and discussion on the various axioms.

Chapter 3: Semantics

1. Kripke Semantics .
2. Modal logics for the representation of time, epistemic knowledge, deontics.

Chapter 4: Knowledge leading to reviewable conclusions

1. Fault logic,
2. riding,
3. self-epistemic,
4. favorite models.

Chapter 5: Semantic Networks

1. Conceptual graphs,
2. Inferences by propagation, logic

Chapter 6: Description logic

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

BIBLIOGRAPHIC REFERENCES :

1. Kayser , D., *"The Representation of Knowledge"* , Paris: Hermes , 1997.

Semester: S4
Course unit: EMU 1.4
Topic 1: Advanced Statistics
VHS: 45h00 (Class: 1h30, TD: 1h30)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

Allow the student to deepen his knowledge of advanced statistics and probabilities.

RECOMMENDED PRIOR KNOWLEDGE:

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

MATERIAL CONTENT

Chapter 1: REMINDER OF DIFFERENTIAL STATISTICS

- Laws and convergences
- Sampling and estimation
- Confidence intervals

Chapter 2: STATISTICAL TESTS

- Introduction
- Hypotheses
- Data, model and decision making
- Risks
- Power of the test
- Hypothesis test and confidence interval
- Practical approach to testing: which test to choose?
- The problem of a parametric test
- Classic parametric tests (z-test, t-test, f-test)

Chapter 3 . STAFF STUDY. KHI-SQUARE TEST

- Representativeness test. fit test (normality test, etc.)
- Homogeneity test
- Independence test

Chapter 4 . TESTS FOR MEANS AND VARIANCES

- Conformity test of a variance for a Gaussian sample
- Compliance test of an average
- Comparison test of 2 variances (Gaussian samples)
- Comparison test of 2 means

Chapter 5 . ONE-WAY ANALYSIS OF VARIANCE

- Position of the problem and presentation of the data

- Notations and model
- Statistical approach
- Implementation using Excel
- Deepening: comparison of means by pairs

Chapter 6. PROPORTION TESTS

- Conformity test of a proportion on large samples
- Comparison test of two proportions (large samples)

Chapter 7. MONTE-CARLO AND RE-SAMPLING METHODS

- Generation of random variables
- Simulation of functions of random variables
- Calculation of an integral by the Monte Carlo method
- Complex Statistics Sampling Distributions
- Missing data and multiple imputation
- Resampling methods

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

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

- JP Lecoutre , Ph. Tassi , Nonparametric Statistics and Robustness (French) Paperback – January 1, 1987. ISBN-10: 2717813012
- Pierre-André Cornillon, Eric Matzner -Lober, Regression: Theory and applications. 2006, Statistics and Applied Probability Collection
- Gérald Baillargeon , Statistical Methods Volume 2, Simple linear regression and multiple regression analysis methods. SMG 2005

Semester: S4
Course unit: EMU 1.4
Subject 2: Basics of image processing
VHS: 45h00 (Course: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

Allow students to understand the principles of image processing methods. Practical work with python/Scala and other tools 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: Introduction and fundamentals of image processing

1. Definition, Image diversity, Color palette
2. Elements of visual perception
3. Light and the electromagnetic spectrum
4. Image detection and acquisition
5. Image sampling and quantification
6. Relationships between pixels

Chapter 2: Basic Operations and Image Enhancements

1. Addition, Subtraction and Division of images
2. Gradient and derivatives
3. Histogram
    a. Definition and Properties
    b. Intensity transformations
    c. Thresholding

Chapter 3: Continuous Fourier Transform,

1. Sampling
2. Quantification

Chapter 4: Discrete Fourier Transform, Color

1. The discrete Fourier transform of a variable
2. Extensions to functions of two variables
3. Some properties
4. The fast Fourier transform

Chapter 5: Convolution and Filtering

1. Definition, Properties, Boundary Problems and Separability
2. Image filtering (spatial and frequency)
3. The Basics of Frequency Domain Filtering

4. Image smoothing using frequency domain low-pass filters
5. Image sharpening using high-pass filters
6. Selective filtering

Chapter 6: Basic Processing

1. Image restoration and reconstruction
2. Edge detection
3. Extraction of primitives

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

BIBLIOGRAPHIC REFERENCES :

1. Gonzalez, RC, Woods, RE, *"Digital Image Processing"* , 4th Edition, 2017, ISBN: 0133356728.

2. Gonzalez, RC, Woods, RE, Steven, LE, *"Digital Image Processing Using MATLAB"* , 2nd Edition., 2009, ISBN: 0982085400.

3. Osher , S., & Paragios , N., "Geometric level set methods in imaging, vision, and graphics", Springer Science & Business Media, 2003.

Semester: S4
Course unit: EMU 1.4
Topic 3: Time Series
VHS: 45h00 (Course: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

Allow the student to deepen his knowledge and
practice statistics and in particular time series and data processing
advances.
Practical exercises in R accompany the course of this module.

RECOMMENDED PRIOR KNOWLEDGE:

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

MATERIAL CONTENT:

Chapter 1 Introduction
- 1.1 Prerequisites
- 1.2 Definition of a univariate time series
- 1.3 Classification of time series
- 1.4 Applications of time series
- 1.5 General analysis methodology

Chapter 2 Spectral representation
- 2.1 Spectral density and distribution
- 2.2 Spectral density of an ARMA process
- Wold decomposition
- 2.4 Nonparametric spectral estimation
- 2.5 Parametric spectral estimation
- 2.6 Time series analysis

Chapter 3 Trends and Seasonal Factors
- 3.1 Definitions and treatments
- 3.2 Analysis
- 3.3 Treatment of trends
- 3.4 Overall processing
- 3.5 Elimination of spectral components

Chapter 4 Linear Prediction - State Models - Kalman Filtering
- 4.1 Linear prediction
- 4.2 State models
- 4.3 Stationarity
- 4.4 The Kalman filter
- 4.5 Missing observations
- 4.6 Irregular observations
- Extended Kalman Filter

Chapter 5 . Exponential smoothings
- 2.1. Single exponential smoothing
- 2.2. Double exponential smoothing

2.3. Holt- Winters method

Chapter 6 ARMA Processes

6.1 Definitions and practical importance
6.2 Covariance, correlation, partial correlation
6.3 State model for an ARMA process
6.4 Spectral density of an ARMA process
6.5 Calculation of the covariance of an ARMA process
6.6 Identification of ARMA processes
6.7 Spectral estimation of ARMA processes
6.8 Linear h-step prediction

Chapter 7 ARIMA and SARIMA process - Periodically correlated process

7.1 ARIMA processes
7.2 SARIMA processes
7.3 Periodically correlated processes

Chapter 8 Long Memory Processes

8.1 A few reminders
8.2 Long Memory Processes

Chapter 9 Box and Je nkins method

9.1 Identification of the ARMA(p,q),
9.2 Estimation by the maximum likelihood method,
9.3 Validation (Box-Pierce test and ARCH test)
9.4 Model selection criteria (MAE, RMSE, MAPE, AIC, Schwarz, Hannan -Quinn).

Chapter 10 GARCH process

10.1 GARCH process - ARMA/GARCH process
10.2 Properties of ARMA/GARCH processes
10.3 Principles of identification
10.4 M-GARCH processes

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

BIBLIOGRAPHIC REFERENCES :

1. Aragon, Y., *"Time series with R"* , EDP sciences, 2016, ISBN-10: 2759817792
2. R., Bourbonnais, M., Terraza , *"Analysis of time series - 4th ed. - Courses and corrected exercises - Applications to economics and management"* , Dunod , 2016, ISBN-10: 2100745360.
4. Decourt , O., *"The R language in everyday life: Big data processing and analysis. Putting it into practice with examples in Open Data (Applications and trades)"* , Dunod , 2018, ASIN: B07B4F7ZKK.

Semester: S4
Course unit: UED 1.4
Subject 1: Digital Technologies in Organization
VHS: 10:30 p.m. (Class: 1:30 a.m.)
Credits: 3
Coefficient: 1

TEACHING OBJECTIVES:

The objective of this course is to understand the impacts of digital technologies on organizations and the strategic role of ICT in organizations.

RECOMMENDED PRIOR KNOWLEDGE:

Know the basic notions of computer science, networks and mathematics.

MATERIAL CONTENT:

Chapter 1: IT in the structure of the organization? What solutions?

Chapter 2: Introduction to Digital Transformation in Organizations

Chapter 3: Strategic Role of ICT in Digital Transformation

Chapter 4 : Ethics in the Digital

ASSESSMENT MODE: Exam (100%).

BIBLIOGRAPHIC REFERENCES:

1. Challande , JF, Lequeux , J. L, *"Le grand livre du DSI. Implementing the management of Information Systems 2.0"* , Eyrolles , 2009.

2. Legrenzi C., and Rosé, P., *"The DSI dashboard, Management, performance and benchmarking of the information system"* , Dunod , 2007.

E. Detailed program of Semester 5

Semester: S5
Course unit: UEF 1.5
Subject 1: Deep Learning
VHS: 67h30 (Class: 1h30, TD: 1h30, TP: 1h30)
Credits: 5
Rating: 3

TEACHING OBJECTIVES:

Enable students to understand the principles of deep learning methods. Practical work with the Python/Scala or other language accompanies 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: Reminder on optimization

1. Linear Regression and Classification
2. Model fitting problem and validation
3. Model regularization
4. Stochastic gradient descent

Chapter 2: Reminder on neural networks

7. Perceptron
8. Train the perceptrons
9. Perceptron training algorithm
10. Activation functions

Chapter 3: Multi-Layer Network

1. Classification with an artificial neural network
2. Deep networks
3. Feedforward
4. Parameter estimation of a neural network
5. Model selection, underfitting and overfitting
6. Backpropagation
7. Improved convergence

Chapter 4: Unsupervised Pretrained Networks

1. Autoencoders
2. Deep Belief Networks (DBNs)
3. Generative Adversarial Networks (GANs)

Chapter 5: Convolutional Neural Networks (CNNs)

1. Intro and Motivation
2. The basics and architecture of Convolutional Neural Networks
3. Convolution layer
4. Pooling layer
5. connected layer
6. Modern networks (LeNet , AlexNet , VGG, NiN , GoogLeNet , ResNet, and DenseNet)

Chapter 6: Recurrent Neural Network (RNN)

1. Sequence models
2. Text preprocessing
3. Architecture of recurrent neural networks
4. Implementation of recurrent neural networks
5. Backpropagation over time
6. gated Recurrent Units (GRUs)
7. Long Short-Term Memory (LSTM)
8. Bidirectional Recurrent Neural Networks

Chapter 7 : Transfer Learning,

1. Conservative formation
2. layer transfer
3. Transfer of learning
4. Multitasking learning
5. Progressive Neural Network

Chapter 8 : Interpretation of deep neural networks

1. Layer Relevance Propagation (LRP)
2. assessment
3. Applications to neuroscience and physics
4. Applications to Images, videos, texts, age

CONTENT OF THE WORKSHOP

The student must learn to develop:

1) Deep models learning in Python and Python deep learning libraries. Particularly
   - TensorFlow Library.
   - Keras Deep Learning Library
   - Theano Library.
2) Develop large models on GPUs in the Cloud (*Colab case*)

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

BIBLIOGRAPHIC REFERENCES :

1. Goodfellow , I., Bengio , Y., Courville , A., & Bengio , Y., *"Deep learning"* , Cambridge: MIT press, 2016, https://www.deeplearningbook.org/ .

2. Géron , A., "Hands-on machine learning with Scikit -Learn, Keras , and TensorFlow : Concepts, tools, and techniques to build intelligent systems", O'Reilly Media, 2019.

3. Nielsen, MA, *"Neural networks and deep learning"* , Vol. 25, San Francisco, CA: Determination press, 2015. http://neuralnetworksanddeeplearning.com/index.html.

4. Fei-Fei , L., Karpathy , A., and Johnson, J., *" Convolutional Neural Networks for Visual Recognition"* , Stanford course, 2016, http://cs231n.github.io/ .

Semester: S5
Course unit: UEF 1.5
Subject 2: Reinforcement Learning
VHS: 67h30 (Class: 1h30, TD: 03h00, TP: 1h30)
Credits: 5
Rating: 3

TEACHING OBJECTIVES:

Enable students to understand the principles of reinforcement learning methods. Practical work with python/Scala 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: Introduction to Reinforcement Learning

- Formulation of a reinforcement learning problem
- Comparison with other machine learning methodologies
- Frameworks for solving reinforcement learning problems

Chapter 2: Dynamic Programming

Chapter 3: Monte Carlo Methods

Chapter 4: Learning by time difference

Chapter 5: Bootstrapping in n-steps

Chapter 6: Planning and learning with tabular methods

Chapter 7: Prediction and control over politics with approximation

Chapter 8: Multi-Agent Technology

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

BIBLIOGRAPHIC REFERENCES :

1. Sutton RS, and Barto , AG, *"Reinforcement Learning: An Introduction"* , Adaptive Computation and Machine Learning series, MIT Press (Bradford Book), 2018.

Semester: S5
Course unit: UEF 2.5
Subject 1: Pattern recognition for image analysis
VHS: 67h30 (Class : 1h30, TD: 1h30, Lab: 1h30)
Credits: 5
Rating: 3

TEACHING OBJECTIVES:

Enable students to understand the principles of Pattern Recognition methods for image analysis. Practical work with python/Scala and other tools accompany the theoretical training of this module.

RECOMMENDED PRIOR KNOWLEDGE:

Knowledge of statistics, machine and deep learning, the basics of image processing and a mastery of programming and mathematical formalism are necessary to follow this module.

MATERIAL CONTENT:

Chapter 1: Introduction and extraction of shape attributes

1. Form clues
   - Definition, construction principles and properties
   - Cartesian moments of a form
   - Central moments: invariance in translation
   - Normalized moments: scale change invariance
   - Invariant moments of Hu
2. Attributes inferred from outline
   - Signature of a shape from its outline
   - Signature according to the curvilinear abscissa
   - Fourier descriptors

Chapter 2: Probabilistic Decision - Bayes Rule, and Discriminant Analysis

Chapter 3: Image Segmentation by Classification

1. Learning and classification
2. Textures
   - Complex property, intuitive approach and statistical approach
   - Co-occurrence matrices
   - Filtering approach - Gabor filters

Chapter 4: Segmentation Regions

Active Contours: Snakes and Level Sets

Chapter 5: Wavelet transform and other image transforms

1. Fourier transforms

- The Discrete HartleyTransform

- The Discrete cosine Transform
- The Discrete Sine Transform

2. Walsh-Hadamard transforms
3. Slant Transforms
4. Haar transforms
5. Wavelet transform

Chapter 6: Image Compression

1. Foundations
2. Huffman coding
3. Golomb coding
4. Wavelet Coding
5. digital tattoo

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

BIBLIOGRAPHIC REFERENCES :

1. Bishop, CM, *"Pattern Recognition And Machine Learning"* , Springer, 2006

2. Gonzalez, RC, Woods, RE, *"Digital Image Processing"* , 4th Edition, 2017, ISBN: 0133356728.

3. Gonzalez, RC, Woods, RE, Steven, LE, *"Digital Image Processing Using MATLAB"* , 2nd Edition., 2009, ISBN: 0982085400.

4. Osher , S., & Paragios , N., "Geometric level set methods in imaging, vision, and graphics", Springer Science & Business Media, 2003.

Semester: S5
Course unit: UEF 2.5
Subject 2: Automatic language processing
VHS: 45h00 (Course: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

The automatic language processing course aims to introduce the student to the field of automatic language processing, in particular on the different phases of text preprocessing for information extraction, NLP approaches and the operation of NLP applications.

RECOMMENDED PRIOR KNOWLEDGE:

Basic knowledge of language theory and Machine Learning is desirable.

MATERIAL CONTENT:

Chapter 1: Introduction to the field of NLP

- Denomination
- Historical overview

Chapter 2: Levels of analysis

- Morphological analysis
- Syntactic analysis
- Semantic analysis
- Pragmatics analysis

Chapter 3: Language Processing Approaches

- Formal methods
- Statistical methods

Chapter 4: NLP Applications

- Information search and extraction
- Text mining
- Auto Resume
- ...

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

BIBLIOGRAPHIC REFERENCES :

1. Hobson. L., Cole, H., Hannes , H., *"Natural Language Processing in Action: Understanding, analyzing, and generating text with Python"* , 1st Ed., Manning Publications, 2017.

2. Manning C., *"Foundations of Statistical Natural Language Processing"* , 4th Ed., MIT Press, 1999.

3. Bird, S., Klein E., & Loper , E., *"Natural Language Processing with Python"* , O'Reilly, 2009.

4. Geron A., *"Hands-On Machine Learning with Scikit -Learn and TensorFlow : Concepts, Tools, and Techniques to Build Intelligent Systems",* O'Reilly, 2017 .

5. Eisenstein, J., *"Natural Language Processing"* , MIT Press, 2019.

Semester: S5
Course unit: EMU 1.5
Subject 1: Business Intelligence
VHS: 67h30 (Class: 1h30, TP: 03h00)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

Enable students to understand the principles of data visualization and Business Intelligence in general. Practical work with R and python software accompany the theoretical training of this module.

RECOMMENDED PRIOR KNOWLEDGE:

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

MATERIAL CONTENT:

Chapter 1 Introduction to Business intelligence

- Business Intelligence
- mobile business intelligence
- Real-Time Business Intelligence
- Business Intelligence process

Chapter 2 Analytics (Analytics) : An In-Depth Study

- Business Analytics _ _
- Analytics Process (Analytics)
- Software analysis
- Integrated analysis
- Learning analysis
- Predictive analytics
- Prescriptive Analytics
- Social media analysis
- Behavioral analysis

Chapter 3 Market Research

- Market research
- Market segmentation
- Market trend
- SWOT analysis
- Marketing Research

Chapter 4 Essentials of Business Intelligence

- Context analysis
- Business performance management
- Discovery of business processes
- Organizational Intelligence

- Data visualization
- Data profiling
- Data cleaning
- Process Mining
- Competitive intelligence

Chapter 5 Operational Intelligence: Technological Components

- Operational intelligence
- Monitoring of business activity
- Complex event processing
- Process management
- Metadata
- Root cause analysis

Chapter 6: Viewing historical data

- Visualization process
- Data Types, Relationships, and Visualization Formats
- Data Visualization Basics
- Storytelling for social and commercial communication
- Market research trends and data visualization dashboards

Chapter 7: Web Dashboards

- Data selection
- Formatting
- Input controls
- Editions
- Analysis Cube
- Filters

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

BIBLIOGRAPHIC REFERENCES:

1. Gendron , J., *"Introduction to R for Business Intelligence"* , Packt Publishing Ltd, 2016.

2. Pimpler E., *"Data Visualization and Exploration with R: A practical guide to using R, RStudio , and Tidyverse for data visualization, exploration, and data science applications"* , CreateSpace Independent Publishing Platform, 2018, ISBN-10: 1727588487.

3. Chunhouh Chen, Wolfgang Hardle , Antony Unwin , *"Handbook of Data Visualization"* 2008 , Springer ISBN 978-3-540-33036-3

Semester: S5
Course unit: EMU 1.5
NoSQL Databases
VHS: 45h00 (Course: 1h30, Lab: 1h30)
Credits: 3
Coefficient: 2

TEACHING OBJECTIVES:

- NoSQL databases (creation, management, querying of data).
- Application of databases in big data.

RECOMMENDED PRIOR KNOWLEDGE:

Understanding of relational databases, SQL query language, notions of database optimization: indexing, hashing, execution plans. Understanding of the basics of Big Data.

MATERIAL CONTENT:

Chapter 1: Introduction

- New data management needs
- Limitations of relational-transactional DBMSs
- Brewer's or CAP's theorem
- The big database landscape

Chapter 2: Foundations of NoSQL Systems

- Features
- Reasoning
- Types
- Disk Storage Devices
- In-memory storage devices

Chapter 3: Major NoSQL Database Models

- Key-Value
- Document
- Column
- graph

Chapter 4: Storage Architecture

- Typical relational storage model
- Merge trees Log-structures
- Secondary indexing

Chapter 5: Languages and programming interfaces

- NoSQL -API
  - Riak
  - Hbase
  - MongoDB
  - Cassandra Query Language (CQL)

    - MapReduce
    - Pig
    - Directed Acyclic Graphs
    - Spark
- The return of SQL
    - Winter
    - Spark SQL
    - Apache Drill

Chapter 6: Hadoop

- The origins of Hadoop
- The power of Hadoop
- The architecture of Hadoop
- HBase
- Hive and Sqoop
- Pig
- Hadoop ecosystem

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

BIBLIOGRAPHIC REFERENCES :

1. Tiwari , S., *"Professional Nosql* ", John Wiley & Sons, 2011.
2. Fowler, A., *" NoSQL for Dummies"* , John Wiley & Sons, 2015.
3. Bruchez , R., *" NoSQL Databases and Big Data"* , 2nd edition, Eyrolles , 2013.
4. Guy, H., *"Next Generation Databases: NoSQL , NewSQL , and Big Data"* , Apress , 2016.
5. Baazizi , MA, "Web Technologies Course (*NoSQL Databases)"* , UPMC-LIP6, 2018.
6. Verel , S., "Introduction to *NoSQL Course "* , University of Littoral Côte d'Opale, 2018.

Semester: S5
Course unit: UED 1.5
Topic 1: Ethics in AI
VHS : 10:30 p.m. (Class: 1:30)
Credits: 3
Coefficient: 1

TEACHING OBJECTIVES:

- Make students aware of:
  - profound transformations underway with the digital revolution
  - existing legal and regulatory frameworks and how to respect them
  - open ethical questions, and ethical reflection for future questions

RECOMMENDED PRIOR KNOWLEDGE:

MATERIAL CONTENT:

Chapter 1 : Introduction: challenges of the digital revolution

Chapter 2: Legal framework for AI

Chapter 3: Responsibility of social networks

Chapter 4: Ethics in the IoT , case of the autonomous vehicle

ASSESSMENT METHOD: Examination (100%).

BIBLIOGRAPHIC REFERENCES :

1. Bahu - Leyser , D., *"An ethics to build"* , Hermès, La Revue, n° 53, p. 161-166, 2009, URL: https://www.cairn.info/revue-hermes-la-revue-2009-1-page-161.htm.

2. Davis, K., *"Ethics of Big Data: Balancing risk and innovation"* , O'Reilly Media, Inc.", 2012.

3. CNIL: "How to allow man to keep control", summary of public debate, December 2017

4. OPECST: "For controlled, useful and demystified artificial intelligence", report, March 2017

5. CERNA / Allistene : "Ethics of research in machine learning", June 2017;

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 practical internship, the students get to know the host company better, gain confidence in their skills and have a clearer idea of their professional goals.
The lessons must allow the students to be given 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 conjunction with the professional environment.

PROGRAM :

1. Choice of project theme
2. Literature search
3. Analysis of existing technical solutions
4. Implementation of hardware and software components
5. Dimensioning and Simulation
6. Validation of technical solutions
7. Dissertation writing associated with the subject

AUTONOMOUS WORK :

Individual work and writing a dissertation.

EVALUATION METHOD:

- Scientific value (Jury assessment) /6
- Dissertation writing (Jury assessment) /5
- Presentation and answer to questions (Jury assessment) /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 the specialty : Artificial Intelligence and Data Science

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