Tunisian Republic Ministry of Higher Education and Scientific Research	Ministère de l'Enseignement Supérieur et de la recherche scientifique	وزارة التعليم العالي والبحث العلمي
University of Manouba	Université de la Manouba	جامعة منوبة
National School of Computer Sciences	ECOLE NATIONALE DES SCIENCES DE L'INFORMATIQUE	المدرسة الوطنية لعلوم الإعلامية

Computer science engineering

Module Handbook

Part I : Common core courses

September 2023

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This module handbook consists of the complete collection of modules description of the whole program offered for ENSI[1] students in the frame of the preparation of their computer science engineering diploma.
It includes the updated description of all the modules and the study program as resulting from the last reform conducted at ENSI in 2021 – 2022 and where all stakeholders were involved. The adoption of the current updated study plan begun in September 2022 and concerns only the newcomers to the first year engineering level since September 2022. It is intended to gradually[2] replace the program established in 2013.
The current study plan describes in detail all the **common and core modules** of the first engineering year and the second engineering year, i.e. from semester 1 to semester 4. It describes also the modules of the fifth semester for each of the six specialization offered by ENSI.
In fact, ENSI students, who successfully validate the four first semesters, choose the "option" they wish, i.e. one among the following **six specializations**:

Specialization Name (English translation)	*French name*	*Used acronym*
Artificial Intelligence	Intelligence Artificielle	IA
Software Engineering	Génie Logiciel	GL
Data Science & computer Vision	Sciences des données et Vision par ordinateur	DS&CV
Financial Engineering	Ingénierie pour la finance	IF
Embedded Software and Systems	Systèmes et logiciels embarqués	SLE
Services, Technologies and Internet of things	Services, Technologies et Internet des objets,	ST-IoT

[1] ENSI : refers to the name of the National School of Computer Sciences (acronym of the French naming and widely used: Ecole Nationale des Sciences de l'Informatique)
[2] The old study plan remains applicable during the academic years 2022-2023 and 2023-2024 for the engineering students who entered ENSI before september 2022 (i.e. being in 2nd or 3rd year in September 2022).

Notations:

- *For each module, the assigned code is defined as follows: XXXX.Y.Z, where*
  - *XXXX : 2 to 4 letters referring to the acronyms of the topic or teaching subject as defined in table 1*
  - *Y : refers to the semester number within the three year studies at ENSI, hence the semesters are numbered from 1 to 6*
  - *Z : refers to the number of the module within the topic or unit*

Table 1: codes defining teaching subjects

AI	*Artificial Intelligence*
AP	*Algorithmic & Programming*
BDC	*Business Digitalization and Communication*
CV	*Computer Vision*
DAT	*Data*
DDP	*Design and Development Project*
DOS	*Distributed and operating Systems*
EHA	*Electronics and Hardware Architecture*
ESDV	*Embedded System design and validation*
ESEP	*Embedded systems & Embedded programming*
FIN	*Finance*
IAP	*IoT Applications Programming*
IMA	*Image*
INT	*Internship*
ISA	*Information Systems Applications*
MAT	*Mathematics*
NET	*Computer Networks*
OS	*Operating Systems*
SE	*Software Engineering*
SEC	*Security*

- *Example : MAT.1.2 refers to the second module of MATHS which is in the first semester S1*

Semester 1 Modules:

code	Title	type	Coefficients	ECTS	Total workload	Contact hours	Private study
MAT.1.1	Probability and Statistics	Compulsory	3	3	75	45	30
MAT.1.2	Engineering Mathematics	Compulsory	3	3	75	45	30
FIN.1.1	Introduction to banking and Financial systems	Compulsory	3	3	75	45	30
EHA.1.1	Digital circuits	Compulsory	3	3	75	45	30
EHA.1.2	Analog Electronics	Compulsory	1,5	1,5	37,5	22,5	15
AI.1.1	Formal Logic	Compulsory	3	3	75	45	30
DAT.1.1	Database Design	Compulsory	3	3	75	45	30
AP.1.1	Algorithmic and Data Structures	Compulsory	3	3	75	45	30
AP.1.2	Advanced C programming	Compulsory	1,5	1,5	37,5	22,5	15
BDC.1.1	Management of Organizations	Compulsory	3	3	75	45	30
BDC.1.2	Language and communication 1	Compulsory	3	3	75	45	30

MAT.1.1 Probability and Statistics

Module designation	MAT.1.1 Probability and Statistics
Semester(s) in which the module is taught	S1
Person responsible for the module	Leila Horchani
Teaching team	Leila Horchani; Nadia Chaouachi, Faten Maddouri
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, assignment
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	Introduction to probability Combinatorics
Module objectives/intended learning outcomes	C1
Content	Chapter I: Reminders -6hours 1. Generalities of probability 2. Discrete Random Variables Chapter II: Continuous Random Variables -12hours 1.Definitions 2.Characteristic function 3.Usual laws Chapter III: Continuous Random Pair -6hours 1.Law of probability of a random vector. 2.Density of a continuous random pair 3.Distribution function. 4.Independence. 5.Marginal laws 6.Sum of two independent c.a.v.'s Chapter IV: Convergence and limit theorems -12hours 1.Almost sure convergence and limit theorems 2.Convergence in probability and in L2 space 3.Convergence in law. 4.Strong law of large numbers 5.Estimates of laws 6.Central Limit Theorem Chapter V: Introduction to Statistics -9hours 1.Point estimation 2.Hypothesis testing 3.Confidence interval
Examination forms	35% continuous evaluation; 65% written exam
Study and examination requirements	10/20
Reading list	- Delmas, J. F., & Jourdain, B. (2006). Modèles aléatoires : applications aux sciences de l'ingénieur et du vivant (431 pages). Springer. - Jourdain, B. (2009). Probabilités et statistique (200 pages). Ellipses. - Lacroix, Y., & Mazliak, L. (2006). Probabilités, variables aléatoires, convergences, conditionnement (192 pages). Ellipses. - Méléard, S. (2010). Introduction à la théorie et au calcul des probabilités (280 pages). Éditions de l'École Polytechnique.

MAT.1.2 Engineering Mathematics

Module designation	MAT.1.2 Engineering Mathematics
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Mhiri Slim
Teaching team	Mhiri Slim, Mohamed Amine Mezguich, Ines Bousnina
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson and practice with Matlab and python
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credits	3ECTS
Required and recommended prerequisites for joining the module	Analysis, Integration, Geometry and Algebra
Module objectives/intended learning outcomes	This course aims to present mathematical methods adapted to the interests of engineering students in the constantly evolving fields of analysis, processing, filtering and estimation of data as a support for information. • In the first part, it aims to introduce, on a mathematical level, the concepts of measurement theory, distributions, convolution and Fourier analysis of signals. • Secondly, a series of practical work sessions using Matlab constitutes a first contact for our engineering students with this programming language which allows them to better understand certain theoretical aspects related to the processing of speech, images and digital transmission. Intended learning outcomes: C1
Content	0 – Applications and Motivation 1 - History 1.1 - Birth of trigonometric series 1.2 - Fourier and the heat equation 1.3 - The question of “arbitrary” functions 1.4 – Convolution and Correlation 2 - Fourier series 2.1 - Periodic functions and distributions 2.2 - Expression of Fourier series 2.3 - Properties of Fourier coefficients 2.4 - Spectrum of a periodic or quasi-periodic function 3 - Fourier transformation in the sense of functions 3.1 - Fourier transform of a function 3.2 - Properties of the transformation d 4 - Fourier transform in the sense of distributions 4.1 - Mathematical bases of distributions 4.2 - Space of distributions 4.3 - Properties of distributions 4.4 - Convolution 4.5 - Examples of distributions 4.6 – Fourier transform of distributions 5 – Analog to digital conversion 5.1 - Sampling and Shannon's rule 5.2 – Quantization and Coding

	5.3 – Discrete Fourier Transform 5.4 – Fast Fourier transform 5.5 – Properties of the digital Fourier transform 6 - EXTENSIONS OF THE CONCEPT OF FOURIER TRANSFORM 6.1 - Laplace transformation 6.2 - Hankel transformation 6.3 – Wavelets
Examination forms	35% continuous eval+65% written exam
Study and examination requirements	10/20
Reading list	- Kelly, S. G. (2008). Advanced Engineering Mathematics with Modeling Applications (522 pages). Boca Raton: CRC Press. - Schwartz, L. (1997). Méthodes mathématiques pour les sciences physiques (391 pages). Hermann. - Petit, R. (1983). L'outil mathématique (226 pages). Masson. - Gasquet, C., & Witomski, P. (1995). Analyse de Fourier et applications. Masson.

FIN.1.1 Introduction to the banking and financial systems

Module designation	FIN.1.1 Introduction to the banking and financial systems
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Snoussi Imen
Teaching team	Amor oueslati, Rania Jammazi
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson
Workload	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3ECTS
Required and recommended prerequisites for joining the module	The course requires knowledge of basic financial mathematics.
Module objectives/intended learning outcomes	The main objective of this course is to familiarize the student with the main concepts of financial mathematics and to provide him/her with the tools and techniques necessary to solve financial problems. These problems can be found in several areas of finance: investments, insurance, amortization, bond management... Intended learning outcomes: C12 and C13.
Content	I. Simple interest 1) Definition and justification of simple interest 1.Definition of interest 2.Justification of interest 2) Practical calculation of simple interest 1.Principle and scope of application 2.Practical calculation 3.Average rate for a series of simultaneous investments 4.Term due, term to mature 5.Effective rate of investment

	3) Practical application of simple interest to some investment and credit instruments 1.The savings account 2.Savings bonds 3.Credit by cash 4.Calculation of interest on savings books 5.Practical calculation of agios on current accounts II. Discounting 1) Basic concepts: definition and different categories of discounting 1.Commercial discounting 2.Rational discounting 3.Equivalence date 4.Renewal of a bill of exchange 5.Common maturity of two or more bills 2) Practice of commercial discounting 1.Calculation of agios 2.Discounting slip 3.Actual discount rate (for the company) 4.Discount placement rate (for the bank) III.Compound interest 1) Principle of discounting and capitalization 1.Definition of compound interest 2.Justification of compound interest 2) Practical calculation of compound interest 1.Principle and scope of application 2.Practical calculation 3)Proportional and equivalent rates 4)Calculation of the earned value in the case of a non-full investment period IV. Annuities 1) The value acquired by a series of constant annuities 1. At the end of the period 2. At the beginning of a period 2)The present value by a sequence of constant annuities 1. End of period 2. Of beginning of periods 3)Average maturity a sequence of constant annuities V)Undivided loans and bonds 1)Undivided loans 1.Definition 2. Repayment 2)Bonds 1. Definition and main characteristics of a bond 2.Repayment
Examination forms	35% continuous eval+65% written exam
Study and examination requirements	10/20
Reading list	-Fontaine, J., & Hamet, J. (2011). Les marchés financiers internationaux (128 pages). PUF. -Gresse, C. (2017). Marchés de taux d'intérêt (256 pages). Economica. -Hull, J. (2014). Options futures et autres actifs dérivés (913 pages). Pearson. -Jacquillat, B., Solnik, B., & Pérignon, C. (2014). Marchés financiers (464 pages). Dunod. -Le Saout, E. (2016). Introduction aux marchés financiers (317 pages). Economica.

EHA.1.1 Digital circuits

Module designation	EHA.1.1 Digital Circuits
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Montassar Ezzine
Teaching team	Montassar EZZINE, Yasser GRITLI, Moez SOLTANI, Rym BESSROUR
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3ECTS
Required and recommended prerequisites for joining the module	Automatic, Physics.
Module objectives/intended learning outcomes	This course expands further the student's skill in analysing and designing analogue circuits involving Transistors and Diodes. More specifically, the proposed sections are aimed: ● to develop skill and knowledge in analysis and design of analogue circuits such as amplifiers, operational amplifiers, and comparators; ● to introduce the basic principal operations, device and circuit characteristics of Diodes and bipolar Transistors; ● to develop a more thorough understanding of why analogue circuits behave in a certain way, and how performances can be improved when feedback is applied; ● to develop intuitive feel for circuit analysis and design; ● to introduce different techniques for A/D and D/A conversion. Intended learning outcomes : C1, C4.
Content	Lesson 1 (05h). Introduction to Digital Circuits Lesson 2 (05h). Number Systems and codes ● Numbering systems ● Base change Binary arithmetic operations ● Hexadecimal arithmetic operations ● The codes - Exercices (05h) Lesson 3 (08h). Boolean algebra and Logic Gates ● Boolean algebra operators ● Boolean algebra theorems ● Representation of a logical function ● Simplification of logical expressions Elementary logic gates ● Universal logic gates ● Other logic gates ● Synthesis of logic circuits - Exercices (05h) Lesson 4 (10h). Combinational Circuits ● Transcoding operators ● Referral operators ● Comparison operators ● Arithmetic operators -Exercices (05h) Lesson 5 (08h). Sequential Circuits

	- Flip flops (asynchronous RS flip-flop, synchronous RS flip-flop, D-type flip-flops, JK-type flip-flops, T-type flip-flops) - Counters (asynchronous counters, synchronous counters) - Shift registers - Exercices (04h)
Examination forms	35% Continues evaluation + 65% Written exam.
Study and examination requirements	10/20
Reading list	- Harris, D. M., & Harris, S. L. (2007). Digital Design and Computer Architecture. Morgan Kaufmann. (720 pages) - Katz, R. H. (1994). Contemporary Logic Design. Benjamin/Cummings. (699 pages) - Brown, S., & Vranesic, Z. (2008). Fundamentals of Digital Logic (EBOOK). McGraw Hill. (935 pages)

EHA.1.2 Analog Electronics

Module designation	EHA.1.2 Analog Electronics
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Yasser GRITLI
Teaching team	Yasser GRITLI, Moez Soltani.
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson
Workload (incl. contact hours, self-study hours)	Total workload:37.5h Contact hours: 22.5h (12.5h Lessons, 10h Exercisse) Private study: 15h
Credit points	1.5 ECTS
Required and recommended prerequisites for joining the module	Automatic, Physics.
Module objectives/intended learning outcomes	This course expands further the student's skill in analysing and designing analogue circuits involving Transistors and Diodes. More specifically, the proposed sections are aimed: ● to develop skill and knowledge in analysis and design of analogue circuits such as amplifiers, operational amplifiers, and comparators; ● to introduce the basic principal operations, device and circuit characteristics of Diodes and bipolar Transistors; ● to develop a more thorough understanding of why analogue circuits behave in a certain way, and how performances can be improved when feedback is applied; ● to develop intuitive feel for circuit analysis and design; ● to introduce different techniques for A/D and D/A conversion. Intended learning outcomes: C1, C4.
Content	Lesson 1 (0.5h). Introduction to Analog Electronics Lesson 2 (01h). Basic Circuit Analysis Lesson 3 (02h). Diodes Lesson 4 (01h). Rectifier Circuits ● Exercices (03) Lesson 5 (02). Bipolar Transistors Lesson 6 (01). Common Emitter/Common Source Amplifier

	Lesson 7 (01). Common Collector/Common Drain Amplifier Lesson 8 (01). Miscellaneous useful Amplifiers ● Exercices (04) Lesson 9 (02h). Op-Amps: Principles and Basic Circuits ● Exercices (02) Lesson 10 (01). Linear Voltage Regulators Lesson 11 (01). Introduction to the different techniques for A/D and D/A conversion.
Examination forms	35% Continues evaluation + 65% Written exam.
Study and examination requirements	10/20
Reading list	- Burns, T., & Bond, G. (1996). Principles of Electronic Circuits (2nd ed.). PWS. (922 pages) - Higgins, R. J. (1983). Electronics with Digital and Analog Integrated Circuits. (650 pages) - Bogart, T. F. (1993). Electronic Devices and Circuits (3rd ed.). Merrill. (1008 pages)

AI.1.1 Formal Logic

Module designation	AI.1.1 Formal Logic
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Hela Boukef
Teaching team	Walid Sadfi, Anja Habacha, Ines Bousnina
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, assignment
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	Boolean Algebra/Sets Theory
Module objectives/intended learning outcomes	This course is an introduction to the tools and fundamental concepts of formal logic. It requires the basic knowledge of truth, demonstration and computability. The goal is to be able to formalize problems, to make deductions and to understand their interest for computer science. This course introduces automatic reasoning and learns how to structure it, by : ● studying the main operators, universal quantifiers and their properties, ● understanding the notions of implication and equivalence, ● modeling a statement to test its validity, ● applying all these notions to the mathematical demonstration in order to test its validity, ● and, by structuring an own reasoning. Intended learning outcomes: C1.
Content	● Chapter 0. Introduction to Formal Logic (1 week) ● Chapter 1. Propositional Logic (Truth-Functional Logic) (4 weeks)

	. Symbolisation 1. Langage definition 2. Decomposition tree of an expression 3. Substitution in an expression I. Semantic Study 1. Concept of Interpretation 2. Validity of an expression 3. Concept of semantic consequence 4. Concept of complete set of connectives 5. Validity of an expression set 6. Normal Expressions 7. Exercise Chapter 2. Quantificational Logic (predicate / first-order) (5weeks) . Symbolisation 1. First order langage definition 2. Langage terms 3. Langage expressions 4. Concept of Free and Bounded Variable 5. Substitution in an expression I. Semantic Study 1. Concept of Structure and L-Structure 2. Expression Interpretation 3. Validity of an expression 4. Concept of semantic consequence 5. Clausal Expression Chapter 3. Introduction to Formal Systems (1 week) . Concept of decidability 1. Concept of recursive function 2. Concept of recursive set 3. Concept of recursively enumerable set 4. Concept of decidable predicate 5. Concept of semi decidable predicate 6. Exemple (lukasiewicz formal system, Mendelshon formal system, …) I. Formal Systems 1. Definitions 2. Formal systems properties 3. General Algorithm Chapter 4. Resolution Method (4 weeks) 1. Closed resolution method 2. Concept of Unification 3. Variable Resolution Method 4. Resolution Strategies
Examination forms	35% continuous evaluation; 65% written exam
Study and examination requirements	10/20
Reading list	- David, R., Nour, K., & Raffali, C. (2019). Introduction à la logique. Éditions Dunod. - Cori, R., & Lascar, D. (2021). Logique mathématique - Tome 1: Calcul propositionnel, algèbre de Boole, calcul des prédicats. Éditions Dunod. - Manin, Y. I. (2010). A Course in Mathematical Logic for Mathematicians. Springer.

DAT.1.1 Database Design

Module designation	DAT.1.1 Data Design
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Raoudha KHCHERIF
Teachers	Chiraz Zribi, Hela Boukef, Marouene Chaieb, Ines Hamdi
Language	French
Relation to curriculum	Compulsory
Teaching methods	lecture, lesson, assignment, labs
Workload (incl. contact hours, self-study hours)	Total workload: 75 h Contact hours: 45 h Private study: 30 h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	AP.1.2
Module objectives/intended learning outcomes	C1, C2, C8 and C13
Content	Chapter1: Introduction to databases Chapter 2: Introduction to the different Models Chapter3: Entity/Association Model Chapter 5: Relational model Chapter 6: Relational Algebra Chapter 7: Introduction to the SQL language Chapter8: NoSQL Databases
Examination forms	35% continuous evaluation+65% written exam
Study and examination requirements	10/20
Reading list	- GARDARIN, G. (2003). Bases de Données. Eyrolles. - Brouard, F., & Soutou, C. (2015). Modélisation de bases de données. Eyrolles. (384 pages) - Brouard, F. (2001). SQL. Pearson. (510 pages) - BRUCHEZ, R. (2015). Les bases de données NoSQL et le BigData. Eyrolles. (315 pages)

AP.1.1 Algorithmic and Data Structures

Module designation	AP.1.1 Algorithmic and Data Structures
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Raoudha Chebil
Teaching team	Dorra DHOUIB , Manel Ben Sassi, Ichrak Amdouni
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, assignment
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3ECTS
Required and recommended prerequisites for joining the module	Basic notions of algorithms
Module objectives/intended learning outcomes	Knowledge : Students: ● Master the sorting algorithms as well as the difference between them;

	● Be able to choose the appropriate data structure for each problem; ● Master the concept of recursivity as well as its interest and apply it adequately; Competences: C1, C8.
Content	Chapter I – Introduction and reminder 1. Structure of an algorithm 2. Data types 3. Basic operations 4. Control structures 5. Modular decomposition Chapter II - Structured Objects 1. Arrays 2. Character strings 3. Structures Application: Sorting algorithms Chapter III – Recursivity 1. Definition and examples 2. Properties of recursive algorithms 3. Execution stack 4. Application: Tower of Hanoi Chapter IV – Dynamic memory allocation 1. Pointer concept 2. Declaration of a pointer 3. Memory reservation 4. Access to the pointed variable 5. Freeing up memory Chapter V – Files 1. Interest of the files 2. Organization 3. Types of access 4. Declaration 5. Instructions Chapter VI – Abstract data types 1. Definition of an ADT 2. Signature of an ADT 3. Description of the properties of an ADT Chapter VII – Lists 1. Definition of lists 2. Abstract data type “List” 3. Representation of lists Chapter VIII - Stacks 1. Definition 2. Abstract data type “Stack” 3. Representation of stacks Chapter IX - Queues 1. Definition 2. Abstract data type « Queue » 3. Representation of queues Chapter X - Binary Trees 1. Definition 2. Terminology 3. Definition of the ADT 4. Measurements on trees 5. Particular binary trees 6. Representation of binary trees 7. Binary tree traversals Chapter XI – Particular Binary Trees

	1. Binary Search Trees 2. Balanced Binary Tree Chapter XII - Graphs 1. Definitions and examples 2. Terminology 3. Representations of graphs
Examination forms	35% continuous evaluation; 65% written exam
Study and examination requirements	10/20
Reading list	● CORMEN, T. H., LEISERSON, C. E., RIVEST, R. L., et al. (1997). *Introduction à l'algorithmique*. Dunod. ● COURTIN, J., & KOWARSKI, I. (1997). *Initiation à l'algorithmique et aux structures de données Volume 2*. Dunod. ● COURTIN, J., & KOWARSKI, I. (1994). *Initiation à l'algorithmique et aux structures de données Volume 1*. Dunod. ● FROIDEVAUX, C., GAUDEL, M.-C., & SORIA, M. (1993). *Types de données et algorithmes*. Ediscience International.

AP.1.2 Advanced C programming

Module designation	AP.1.2 Advanced C Programming
Semester(s) in which the module is taught	S1
Person responsible for the module (coordinator)	Rihab Said
Teaching team	Hatem Aouadi, Hamza Gharsallaoui
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, lab work and project.
Workload (incl. contact hours, self-study hours)	Total workload: 37.5h Contact hours : 22.5h (11h lessons, 11.5h lab works) Private study: 15h
Credit points	1.5 ECTS
Required and recommended prerequisites for joining the module	No Requirements
Module objectives/intended learning outcomes	Students discover basic notions of C langage and develop cognitive and practical abilities to use IDE softwares Intended learning outcomes: C8
Content	Chapter I – The basic notions of the C language (1h) 1. Introduction 2. Structure of a C program 3. Types, variables and constants in C 4. Basic operations in C 5. Operators in C 6. Type casting 7. Standard arithmetic functions =>Lab Works (1h) Chapter II - Control structures (1h) 1. Conditional structures 2. Iterative structures =>Lab Works (1h) Chapter III - Structured objects(2h)

	1. One-dimensional arrays 2. Two-dimensional arrays 3. Character strings 4. Arrays of character strings 5. Structures =>Lab Works (2h) Chapter IV – Pointers(2h) 1. Definition 2. Declaration of a pointer 3. Assignment of pointers 4. Operators 5. Dynamic allocation 6. Pointers and Arrays 7. Pointers and string constants 8. Array of pointers =>Lab Works (2h) Chapter V - Functions in C (1h) 1. Introduction 2. Definition of a function 3. Declaration of a function 4. Returning the result of a function 5. Global Variables 6. Local variables 7. Passing parameters in a function =>Lab Works (1h) Chapter VI - linked lists in C (1.5h) 1. Simple linked list 2. Sorted linked list 3. Doubly linked list =>Lab Works (1.5h) Chapter VII - stack and queue in C (1.5h) 1. Create a stack system 2. Stacking an element 3. Popping an element 4. Build a queue structure =>Lab Works (1h) Chapter VIII - File management in C(1h) 1. Opening and closing a file 2. Write to a file 3. Read from a file 4. Rename a file 5. Delete a file =>Lab Works (1h)
Examination forms	50% continuous evaluation + 50% project evaluation
Study and examination requirements	10/20
Reading list	- Isiak, A., & Isiak, A. (2022). *C Programming: A Definitive Method for Learning the Basics of the C Language*. Inside Topics at a Glimpse. - Kanetkar, Y. (2022). *Let Us C: An Authentic Guide to C Programming Language* (17th ed.). In Paper Knowledge. - Faber, F. (2014). *Introduction à la programmation en ANSI-C*. En ligne.

BDC.1.1 Management of Organizations

Module designation	BDC.1.1 : Management of Organizations

Semester(s) in which the module is taught	S1
Person responsible for the module	Houda HAKIM GUERMAZI.
Team	Wissem Ben Saiid, Mokrani Fatma
Language	French
Relation to curriculum	Compulsory
Teaching methods	lecture, lesson, project
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	No prerequisites for joining the module
Module objectives/intended learning outcomes	-Familiarize students with Economics and management concepts - Help students to : ● Identify the Strategic management Process . ● Identify business relationship and business environment ● To master financial department functions ● To master MKG department functions ● To master HR department functions Intended learning outcomes: C12, C13
Core Competences	strategic planning and management skills Competence in conflict management and problem solving and decision making Leadership Competence Competence in Finance management Competence in Mrk management Competence in HR management
Content	• Economies and Management • Business Management • businessenvironment • financialdepartment • MKG department • HR department
Examination forms	35% continuous evaluation; 65% written exam
Study and examination requirements	10/20
Reading list	● Zerbib, R. (2020). *Les modes managériales: Du conformisme à l'innovation*. Editions EMS. ● Wirtz, B. W. (2019). *Digital Business Models*. Springer. ● Brocke, J., & Mendling, J. (2017). *Business Process Management Cases: Digital Innovation and Business Transformation in Practice*. ● Prades, N. (2015). *Lexique du marketing*. Édition Bréal. (176 pages). ● Kotler, P., Keller, K., & Manceau, D. (2015). *Marketing Management*. Pearson. ● Thomas, P. (2014). *Principes de finance d'entreprise: Corporate Finance - Création de valeur*. Édition Revue Banque. ● Mintzberg, H. (1986). *Le pouvoir dans les organisations*. Les éditions d'organisation. ● Mintzberg, H. (1990). *Voyage au centre des organisations*. Edition d'Organisation. ● Pouget, M. (1998). *Taylor et le taylorisme*. PUF, Que-sais-je, n° 3318.

	● Schermerhorn, R. J., Chappell, S. D., & Lambert, J. (2008). *Principes de management* (2e édition). Éditions du renouveau pédagogique inc.

BDC.1.2 Language and communication I: English For Computer Science

Module designation	BDC.1.2 Language and communication I: English For Computer Science
Semester(s) in which the module is taught	S1 or S2
Person responsible for the module (coordinator)	Faycel DHAKHLAOUI
Teaching team	Hanen JAYARI
Language	English
Relation to curriculum	Compulsory
Teaching methods	Lecture, project, group work
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (15h lessons, 30h practice) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	E.g. General English intermediate level
Module objectives/intended learning outcomes	- Familarize learners with the basics of the computer system and the latest development in the field. - Develop communicative skills involved in the job of a computer science engineer. - Develop writing skills specific to business correspondence Intended learning outcomes: C11.
Content	Unit 1: Computer engineering Lesson 1: computer as a magic box 1- Pre-reading: speaking: important inventions 2- Reading: Ever tried talking to a computer 3- Language: Word formation 4- Writing: features of an up-to-date computer Lesson 2: Computer engineering 1- Speaking: commenting on the characteristics of a successful engineer 2- Reading: Hoover on engineering 3- Vocabulary 4- Language: Direct Vs indirect speech 5- Writing: turning a diagram into a paragraph Lesson 3: Computer networks 1- Pre-reading: Vocabulary WAN and LAN 2- Reading: Computer networks 3- Vocabulary 4- Language: Tenses Lesson 4: Information society 1- Speaking: The meaning of information society 2- Listening: Information society 3- Writing: paragraph writing: topic sentences and details Lesson 5: Optimizing research on the net 1- Speaking: Features of a good search engine 2- Reading: Searching for the best engine

	3- Vocabulary 4- Language focus: word formation Lesson 6: IT services 1- Pre-reading: new concepts 2- Reading: Indian software put the case for outsourcing to home office 3- Vocabulary 4- Language: tenses 5- Writing: abbreviations Unit 2: Internet and Business Lesson 7: Web 2.0 1- Speaking: definition of Web 2.0 2- Reading: Web 2.0 3- Language: word formation and tenses Unit 3: Information, technology and society Lesson 8: Kids and technology 1- Speaking: computer techies 2- Listening: Technology and kids 3- Language and vocabulary: disadvantages of the internet Lesson 9: Ergonomics 1- Speaking: definition of ergonomics 2- Listening: Video on the definition ofergonomics 3- Language: Word formation 4- Writing: Internet and the danger of being antisocial Lesson 10: Digitalisation 1- Language: word formation 2- Reading: the digital office 3- Writing: The impact of a digital world Lesson 11: Biotechnology 1- Speaking: GM foods 2- Listening: Biotechnology 3- Writing: formal letters
Examination forms	oral presentation, mini project and essay writing. 50% continuous evaluation; 50% written exam
Study and examination requirements	10/20
Reading list	Boeckner, K., & Brown, P. C. (1993). *Oxford English for Computing*. Oxford: Oxford University Press. McCarthy, M., & O'Dell, F. (2002). *English Vocabulary in Use Advanced*. Cambridge: Cambridge University Press. Remacha Esteras, S. (2002). *Infotech English for Computer Users*. Cambridge: Cambridge University Press. http://www.elllo.org/ http://www.esl-lab.com/ http://learnenglish.britishcouncil.org/en/ http://www.zdnet.com/

Semester 2 Modules:

code	Title	type	Coefficients	ECTS	Total workload	Contact hours	Private study
MAT.2.1	Graph algorithms	Compulsory	3	3	75	45	30
MAT.2.2	Numerical methods	Compulsory	3	3	75	45	30
EHA.2.1	Microprocessor and microcontroller engineering	Compulsory	3	3	75	45	30
NET.2.1	Digital transmission	Compulsory	3	3	75	45	30
OS.2.1	Introduction to operating systems and Unix environment	Compulsory	3	3	75	45	30
AP.2.1	object-oriented programming	Compulsory	3	3	75	45	30
AP.2.2	Web technologies	Compulsory	1,5	1,5	37,5	22,5	15
AP.2.3	Automata theory and Languages	Compulsory	3	3	75	45	30
DAT.2.1	Database Management Systems	Compulsory	1,5	1,5	37,5	22,5	15
IMA.2.1	Introduction to Image processing (Computer vision)	Compulsory	3	3	75	45	30
BDC.2.1	Language and communication 2	Compulsory	3	3	75	45	30

MAT.2.1 Graph algorithms

Module designation	MAT.2.1 Graph algorithms
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Nadia Chaouachi
Teaching team	Moncef Tagina; Leila Horchani
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, assignment
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	algorithms and data structure (AP.1.2) advanced C Programming (AP.1.3)
Module objectives/intended learning outcomes	C1/C4/C13
Content	Chapter I: Basic concepts of graph theory (6 hours) 1. Basic definitions and concepts 2. graph representation (matrices, lists …) 3. Connectivity (weakly and strongly connected components, articulation points, isthmus) Chapter II: Extremal paths of weighted graphs (15 hours) 1. Typology of optimization problems (depending on the nature of the valuations, the graph structure and the considered problem) a. Moore–Dijkstra algorithm b. Bellman-Ford algorithm c. Floyd algorithm 2.Application : The scheduling problem (MPM-PERT) Chapter III: Minimum Spanning Tree-MST (9 hours) 1. Définitions and properties 2. Resolution algorithms (Prim, Kruskal, Edmonds – Karp) 3. Related problem : Steiner tree Chapter IV : Flow Network (15 hours) 1. Concepts useful to Flow problems (Definitions and properties) 2. Maximum flow problem: Ford – Fulkerson algorithm 3. Cuts: Max-Flow Min-Cut theorem 4. Feasible Flows : Hoffman theorem 5. Minimum cost flow problem : Busacker-Gowen algorithm 6. Applications : a. Matchings and Coverings in Bipartite Graphs

	b. The Optimal Assignment problem
Examination forms	35% continuous evaluation; 65% written exam
Study and examination requirements	10/20
Reading list	● Charon, A., Germa, O., & Hudry. (1996). *Méthodes d'optimisation combinatoire*. Masson. ● Cormen, T., Leiserson, C., Rivest, R., & Stein, C. (2004). *Introduction à l'algorithmique* (2ème édition). Dunod. ● Gondran, M., & Minoux, M. *Graphes et algorithmes*. Eyrolles. ● Lacomme, C., Prins, C., & Sevaux, M. (2003). *Algorithmes de graphes*. Eyrolles. ● Vazirani, V. V. (2001). *Approximation Algorithms*. Springer.

MAT.2.2 Numerical methods

Module designation	MAT.2.2 Numerical methods
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Nacef Elloumi
Teaching team	Sarra Smaali, Fethi Kadhi
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, assignment
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	Analysis (Preparatory classes level) Linear Algebra
Module objectives/intended learning outcomes	C1
Content	Chapter I: Numerical interpolation and approximation- 10.5hours 1.Lagrange interpolation a. Lagrange's formula, Newton's formula (divided differences) b. Estimation of the interpolation error c. Interpolation at Chebyshev points d. Convergence and stability (Runge phenomenon). 2. Hermite interpolation a. Hermite formula b. Hermite interpolation error. 3. Polynomial approximation a. Principle b. The least squares method c. The discrete least squares method-Numerical regression Chapter II: Numerical integration -10.5 hours 1. Elementary quadrature methods a. Newton-Cotes methods: Principle, examples b. Integration error 2. Composite methods

	3. Gauss methods (Principle, Gauss integration error). Chapter III: Numerical solution of linear systems-15hours 1. Direct solution methods a. Gaussian elimination b. LU decomposition c. Cholesky decomposition 2. Iterative methods a. General principle b. Jacobi method. c. Gauss-Seidel method. d. Relaxation methods. e. Convergence of the iterative methods. 3. Gradient methods a. Stationary methods b. Optimized Gradient method c. Conjugate Gradient Algorithm. d. Conditioning and Accuracy. e. Preconditioning. Chapter IV: Numerical calculation of eigenvalues -9hours 1. Introduction 2. Power method 3. Jacobi method. 4. QR method.
Examination forms	35% continuous evaluation; 65% written exam
Study and examination requirements	10/20
Reading list	• Chapra, S.C., & Canale, R.P. (1998). *Numerical methods for engineers, volume 2*. Mcgraw-Hill, New York. • Quarteroni, A.M., Sacco, R., & Saleri, F. (2000). *Méthodes numériques pour le calcul scientifique: programmes en MATLAB*. Springer Science & Business Media. • Quarteroni, A.M., Sacco, R., & Saleri, F. (2006). *Numerical Mathematics*. Texts in Applied Mathematics. Springer-Verlag. • Quarteroni, A., & Saleri, F. (2006). *Calcul scientifique, Cours, exercices corrigés et illustrations en MATLAB et Octave*. Springer. • Saad, Y. (1996). *Iterative Methods for sparse linear systems*. PWS Publishing Company, Boston. • Théodor, R. (1992). *Initiation à l'analyse numérique*. Masson.

EHA.2.1 Microprocessor and microcontroller engineering

Module designation	EHA.2.1 Microprocessor and microcontroller engineering
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Imed Abdesselem
Teaching Team	Lassaad Latrevh, Rym Besrour, Imed Abdesselem, Montasser Ezzine
Language	French
Relation to curriculum	Compulsor
Teaching methods	lesson, lab works
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h lab works) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	EHA.1.2 Analogue Electronics EHA.1.1 Digital Circuits
Module objectives/intended learning outcomes	Students are expected to have the following topical knowledge upon entering this course : ● Sufficient knowledge of various digital blocks like registers, flip flop … ● Ability to write algorithms for a particular task. Students will learn architecture of 8086 microprocessor and its applications; Students will be able to write assembly language programs for 8086 microprocessor Students will learn to interface processor with peripherals. Intended learning outcomes: C1, C4.
Content	Chapter1 : Microprocessor based systems ● Digital computer, ● Microprocessor, ● Van Neumann and Harvard Architecture, ● CISC and RISCProcessors Chapter2 : Memory RAM, ROM…. Chapter3 : 8086 Microprocessor ● Architectural Block Diagram, ● Schematic and Pin diagrams, ● Pin functions, ● Bus Organization, ● Internal operations and registers, ● Externally initiated operations, ● Timing and Control Unit, ● Microprocessor communication, ● Multiplexing of address/data bus, ● Generation of control signals, ● 8086 machine cycles,Fetch and execution of only MOV Chapter4 : 8086 Assembly language programming ● Programming model of 8086,

	● Addressing modes, ● programming of 8086 based on data transfer, ● arithmetic and logical group, ● branching instructions, ● bit manipulation instructions and I/O Port programming. ● Concept of stack, subroutine and related instructions
Examination forms	35% Continues evaluation + 65% Written exam.
Study and examination requirements	10/20
Reading list	- Harris, D.M., & Harris, S.L. (2007). *Digital Design and Computer Architecture*. Morgan Kaufmann. - Zanella, P., Ligier, Y., & Lazard, E. (2018). *Architecture et technologies des ordinateurs*. DUNOD.

NET.2.1 Digital transmission

Module designation	NET 2.1 Digital Transmission
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Yasser Gritli
Teaching team	Dorra Dhouib, Leila Nasraoui, Ines Bousnina
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, assignment
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3ECTS
Required and recommended prerequisites for joining the module	MAT.1.2, EHA.1.1, EHA.1.2,
Module objectives/intended learning outcomes	C1, C3, C5 and C7.
Content	Lecture 1: Introduction to OSI Model (layers and their functions with a focus on the PHY one:synchronization, multiplexing, transmission medium,…) Lecture 2: Baseband analog modulation (AM, FM, PM, and their applications) Lecture 3: Baseband digital modulation (Serial encoding mechanism NRZ, RZ, Manchester and their applications: ADSL, WiFi, Special Line). Lecture 4: Optimum receiver design and performance (analysis for AWGN channels). Lecture 5 : Passband digital modulation (FSK, PSK, ASK, QAM). Lecture 6 : Digital pulse modulation (PAM, PWM, PCM).
Examination forms	35% continuous evaluation + 65% written exam
Study and examination requirements	10/20
Reading list	- Xiong, F. (2006). *Digital Modulation Techniques* (Artech House Telecommunications Library). Artech House, Inc. - Harris, S. L., & Harris, D. (2015). *Digital Design and Computer Architecture*. Morgan Kaufmann.

OS.2.1 Introduction to operating systems and Unix environment

Module designation	OS.2.1 Introduction to operating systems and Unix environment
Semester(s) in which the module is taught	S2
Person responsible for the module	Maher Sellami
Teachers team	Chiraz Houadia; Hanen Idoudi; Manel Ben Sassi; Ichrak Amdouni; Mehrez Essafi
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, labs
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (21h lessons, 24h lab works) Private study including examination preparation: 30h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	AP.1.3 Advanced C programming EHA.2.1 Architecture and microprocessors
Module objectives/intended learning outcomes	At the end of the course, the students will : - know software architecture of operating systems, - Discover the UNIX system, - Study the development tools for programs, - Master the system interfaces: SHELL, API, - Understand the basics of file management systems. Intended learning outcomes: C8
Content	1) Architecture and Functional Blocks 2) General presentation of operating systems 2.1) Definition and objectives of an operating system 2.2) Evolution of operating systems 2.3) Functions of an operating system 2.4) Structure of an operating system 2.5) Characteristics of Modern Operating Systems 3) UNIX environment 3.1) The File System 3.2) The shell 3.3) The grep, sed, awk, find, sort filters 4) Programming under GNU/LINUX 4.1) Program translation chain 4.2) Compiling with GCC 4.3) The MAKE configurator 4.4) Debugging with the GNU Debugger (GDB) 4.5) Runtime environment, error management, … 4.6) Writing and using Libraries 5) The file management system 5.1) Organization of a file management system 5.2) Basic file access primitives 5.3) Security and File Protection 5.4) The UNIX file system (basic I/O, directory, inode)
Examination forms	50% continuous assessment (mid-term exam + lab works) + 50% written exam
Study and examination requirements	10/20

Reading list	- Tanenbaum, A. S. (2008). *Modern Operating Systems* (3rd ed.). Pearson Education Ink., Prentice-Hall. - Kernighan, B. W., & Pike, R. (Year of Publication). *The Unix Programming Environment*. Prentice-Hall. - Ouergui, M. S. (2004). *Les systèmes d'exploitation Unix/Linux par la pratique*. CPU Tunis.

AP.2.1 Object-oriented programming

Module designation	AP.2.1 Object-Oriented Programming
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Imtiez Fliss
Teaching teams	Imen Boukris ; Raoudha Chebil ;Ichrak Amdouni ; Aroua Hdhili
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, lab works, projects.
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h projects) Private study including examination preparation:30h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	AP.1.2 Algorithmics and data structures AP.1.3 Advanced C programming
Module objectives/intended learning outcomes	Students know the object-oriented paradigm. Students understand the interest and origins of Object-Oriented Programming (OOP). Students learn the new concepts introduced by the OOP style. Students become familiar with the C++ and Java programming languages and learn to use them to program in an object style. Intended learning outcomes: C8, C9.
Content	Part 0: INTRODUCTION 1. Programming challenges 2. Limitations of Structured Programming 3. FROM C TO C++: Brief history 4. Basic principles of object-oriented Part 1: C++ programming 1. Classes in C++ 2. Inheritance in C++ 3. Polymorphism in C++ Part 2: Java programming 1. Introduction to Java 2. Classes, objects and additional notions in Java 3. Inheritance and polymorphism in Java 4. Abstract classes and interfaces in Java 5. Packages and visibility rules 6. Exceptions 7. Input/output in Java 8. Some basic classes in Java
Examination forms	35% continuous assessment + 65% written exam

Study and examination requirements	10/20
Reading list	1. Delannoy, C. (2014). *Programmer en langage C++ Avec une intro aux design patterns et une annexe sur la norme C++11* (8th ed.). Eyrolles. 2. Delannoy, C. (2007). *C++ pour les programmeurs C*. Eyrolles. 3. Delannoy, C. (2007). *Exercices en langage C++* (3rd ed.). Eyrolles. 4. Budd, T. (1992). *Introduction à la programmation par objets*. Addison-Wesley. 5. Bersini, H., & Wellesz, I. (2004). *L'orienté objet Cours et exercices en UML2 avec Python, Java, Csharp et C++* (2nd ed.). Eyrolles. 6. Stroustrup, B. (1997). *The C++ Programming Language* (3rd ed.). Addison-Wesley Professional. 7. Brondeau, J. (*1997*). *Introduction à la programmation objet en Java, Cours et exercices*. Dunod.

AP.2.2 Web technologies

Module designation	AP.2.2 Web technologies
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Maroua Bakri
Teaching teams	Yemna Sayeb, Hatem Aouadi, Rihab Said
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, lab works, projects.
Workload (incl. contact hours, self-study hours)	Total workload: 37.5h Contact hours: 22.5h Private study: 15h
Credit points	1.5ECTS
Required and recommended prerequisites for joining the module	AP.1.2 Algorithmics and data structures
Module objectives/intended learning outcomes	This course is intended for beginners in the design and implementation of static and dynamic websites. It covers the basic concepts and syntax of the programming languages used to implement websites. At the end of this course, students will: - Be familiar with web programming languages, namely: HTML, CSS, Javascript and PHP. - Be able to develop static as well as dynamic websites. Intended learning outcomes: C8, C9.
Content	Chapter I: Web Programming ● Basic concepts ● Client/Server Programming Model ● HTTP Service ● Web Server ● Cookies, cache, proxy and firewall ● Client-Side Web Programming ● Server-Side Web Programming Chapter II: HTML ● Introduction (Definition, Versions of HTML and HTML Document Validation) ● Tags and Attributes ● Global Structure of a HTML document

	• Structuring the content of a HTML document (Text, Titles, Comments Lists, Images, Links, Arrays, Video and audio, Forms) Chapter III: CSS • Introduction (Definition, Versions and Utility of CSS language) • CSS Syntax • Notion of inheritance • Where to place CSS code? • Notions of Class & ID • Tags DIV & SPAN • Borders and margins • Text formatting in CSS • Page Background in CSS Chapter IV: Javascript Language • Introduction (Definition and Utility of Javascript language) • Insertion of JavaScript code in a HTML page • Conventions • Logical Tests • Loops • Functions • Objects & proprieties • DOM • Events Chapter V: PHP Language • Introduction (Definition, PHP Versions and principal advantages) • PHP Code Integration • Lifecycle of a PHP page • Data Types • Mathematical Functions • Boolean Operators • Conditional Instructions • Iterative Instructions • Error management • Sessions • Sending e-mails with PHP • Access to a MySQL database with PHP
Examination forms	50% continous eval + 50% project eval
Study and examination requirements	10/20
Reading list	• Veeraswamy, A. (2013). Fundamentals Of Web Technologies: A Practical Approach (192 pages). LAP LAMBERT Academic Publishing. • Kogent Learning Solutions Inc. (2009). Web Technologies: HTML, Javascript, PHP, Java, Jsp, XML and Ajax. Wiley.

AP.2.3 Automata theory and Languages

Module designation	AP.2.3 Automata Theory and Languages
Semester(s) in which the module is taught	S2
Person responsible for the module	Leila Ben Ayed
Team	Walid Sadfi, Ines Hamdi
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, project
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours 45h (30h Lessons, 15h Exercices and Project) Private study including examination preparation: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	Mathematical Foundations of Computer Science (Set Theory and Function Theory), Formal logic (IA.1.1) and Data structures and Algorithms (AP.1.2.)
Module objectives/intended learning outcomes	Formal Languages and Automat Theory deals with the concepts of automata, formal languages, grammar, algorithms, computability, decidability, and complexity. The reasons to study Formal Languages and Automata Theory are Automata Theory provides a simple, elegant view of the complex machine that we call a computer. Automata Theory possesses a high degree of permanence and stability, in contrast with the changing paradigms of the technology, development, and management of computer systems. Further, parts of the Automata theory have direct bearing on practice, such as Automata on circuit design and compiler design. We focus on three processes: representation, recognition and generation for regular, non-contextual and contextual languages. Knowledge: ● Develop a formal notation for strings, languages and machines. ● Design finite automata to accept a set of strings of a language. ● Prove that a given language is regular and apply the closure properties of languages. ● Design context free grammars to generate strings from a context free language and convert them into normal forms. ● Prove equivalence of languages accepted by Push Down Automata and languages generated by context free grammars. ● Identify the hierarchy of formal languages, grammars and machines ● Distinguish between computability and non-computability and Decidability and undecidability. Competencies: C1, C2.
Content	Lesson I (03h). Strings, Alphabet, Language , Operations Lesson II (09h). Finite automaton model - Acceptance of strings, and languages - Deterministic finite automaton and non-deterministic finite automata - Transition diagrams and Language recognizers. - Significance, acceptance of languages. - Conversions and Equivalence : NFA to DFA conversion

	- Minimisation of FSM - Regular sets, regular expressions, identity rules, - Constructing finite Automata for a given regular expressions - Conversion of Finite Automata to Regular expressions - Pumping lemma of regular sets Lesson III (03h) . Grammars - Regular grammars - Right linear and left linear grammars, - Equivalence between regular linear grammar and FA Lesson IV (06h). Context free grammar - Derivation trees sentential forms - Right most and leftmost derivation of strings - Ambiguity in context free grammars. - Chomsky normal form, Greiback normal form - Pumping Lemma for Context Free Languages - Enumeration of properties of CFL Lesson V (09h). Push down automata, definition, model, acceptance - Acceptance by final state and acceptance by empty state and its equivalence - Equivalence of CFL and PDA, interconversion. Lesson VI (09). Introduction to DCFL and DPDA - Turing Machine, definition, model, design of TM - Computable functions, - Recursively enumerable languages - Church's hypothesis, counter machine - Types of Turing machines Chomsky hierarchy of languages - Decidability of problems - Universal Turing Machine, undecidability of problems
Examination forms	35% Continuous evaluation + 65% Written exam
Study and examination requirements	10/20
Reading list	- Hopcroft, J., Motwani, R., & Ullman, J. D. (2001). *Introduction to Automata Theory, Languages, and Computation*. Addison-Wesley. - Hopcroft, J. E., Motwani, R., & Ullman, J. D. (2001). Introduction to automata theory, languages, and computation. *ACM SIGACT News, 32*(1), 60-65. - Aho, A., Sethi, R., & Ullman, J. D. (1991). *Compilateurs Principes, Techniques et Outils*. InterEditions.

DAT.2.1 Database Management Systems

Module designation	DAT.2.1 Database Management Systems
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Raoudha KHCHERIF
Teachers	Hela Boukef, Rihab Said, Hamza Gharsallaoui
Language	French
Relation to curriculum	Compulsory
Teaching methods	lecture, lesson, assignment, labs
Workload (incl. contact hours, self-study hours)	Total workload: 37,5h Contact hours: 22,5h exercises and lab works Private study: 15h
Credit points	1,5 ECTS
Required and recommended prerequisites for joining the module	DAT2.1

Module objectives/intended learning outcomes	C2, C8, C13
Content	• Installing Oracle • Data Definition Language • Labs Data Manipulation Language • Labs The PL/SQL language • Labs
Examination forms	50% continuous 50% Project evaluation
Study and examination requirements	10/20
Reading list	- De Haan, L., Goramn, T., Jorgensen, I., & Caffrey, M. (2014). *Beginning Oracle SQL for Oracle Database 12c*. Apress. - Feuerstein, S., Pribyl, B., & Dawes, C. (2015). *Oracle PL/SQL Language Pocket Reference*. O'Reilly.

IMA.2.1 Introduction to Image Processing (Computer Vision)

Module designation	IMA.2.1 Introduction to Image Processing
Semester(s) in which the module is taught	S2
Person responsible for the module (coordinator)	Mhiri Slim
Teaching team	Mhiri Slim, Mohamed Amine Mezguich, Majdi Jeribi, Dorsaf Sbei
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, laboratory sessions, mini-projects
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h Private study: 30h.
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	Engineering Mathematics, Analysis, Integration, Geometry and Algebra
Module objectives/intended learning outcomes	This course covers fundamental notions in image and video processing, as well as covers most popular tools used, such as edge detection, motion estimation, segmentation, and compression. It is composed of lectures, laboratory sessions, and mini-projects. Competences: C1, C9
Content	Introduction: acquisition, restitution Two-dimensionnal signals and systems : • Elementary signals, Properties of two-dimentional Fourier transform, Discretization (spatial and spatio-temporal artefacts), • Two-dimensional digital filters, • Two-dimensional z-transform, • Transfer function. Captors, monitors, printers, half-toning, color spaces.

	Multi-dimensional filtres Design of Infinite Impulse Response and Finite Impulse Response filters, Implementation of multi-dimensional filters : ● Directional decomposition and directional filters, ● M-D Sub-band filters, ● M-D Wavelets. Visual perception Neural system : Eye, Retina, Visual cortex, Model of visual system, Special effects, Mach phenomena and lateral inhibition, Color, Temporal vision. Contour and feature extraction : ● segmentation Local methods, ● Region based methods, ● Global methods, Canny, ● Mathematical morphology. Segmentation, Motion estimation Visual information coding ● Overview of the information theory and basics of rate-distortion, ● Conventional techniques : predictive coding, transform coding, subband coding, vector quantization, ● Advanced methods : multiresolution coding, perception based coding, region based coding, directional coding, fractals, Video coding : motion compensation, digital TV, High definition TV. ● Standards: JPEG, MPEG, H.261, H.263
Examination forms	35% continuous eval+65% written exam
Study and examination requirements	10/20
Reading list	Jain, A. K. (1989). Fundamentals of Digital Image Processing: Course Handouts (296 pages).

BDC.2.1 Language and communication 2: *Communication techniques*

Module designation	BDC.2.1 LANGUAGE AND COMMUNICATION 2 : Communication techniques
Semester(s) in which the module is taught	S1 or S2
Person responsible for the module (coordinator)	Sabry NEJI
Team	
Language	French
Relation to curriculum	Compulsory
Teaching methods	lecture, lesson, presentations.
Workload (incl. contact hours, self-study hours)	(Estimated) Total workload: 75h Contact hours: 45h (12h lessons, 33h exercices) Private study including examination preparation, specified in hours : 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	- French language rules used in communication (logical articulators, deictics, modal verbs and adverbs…) - Exchanging ideas in a consistent way.

	- Speaking fluently.
Module objectives/intended learning outcomes	learning objectives : - Being able to exchange thoughts and opinions harmoniously. - Building a solid argumentation using the suitable communication techniques. - Listening and discussing other people's opinions. - Developing critical thinking. - Acquiring the necessary tools for discussions and debates. - Knowing how to speak in public, presenting an exposé and convince the audience. Competences: C11, C12
Content	. **Chapter I How to write a professional document** - respecting the norms at the level of the form and the content. - Different types of professional writings - Presentation of the communication schemes Competence to be valorized : mastering writing while setting clear objectives. **Chapter II: what are the characteristics of the professional writing** - layout of the message - structure, style and syntax - examples of professional writings (CV, application letter, email, summary report...) Competence to be valorized : mastering writing while setting clear objectives. **Chapter III: Objectives of professional writing** - The art of transmitting and communicating - Helping to understand communication problematics - Argumentation serving the professional writing. Competences to be acquired: convincing and reacting **Chapter IV improving linguistic skills** - Reading and writing in a smooth way - Structure, style and syntax - constructing complex statements and writing elaborated texts Competences to be acquired: speeking and writing fluently, expressing an complex opinion.
Examination forms	oral presentation, mini project and essay writing. 50% continuous evaluation; 50% written exam
Study and examination requirements	*10/20*
Reading list	**Bourdieu, Pierre**, *Le Sens pratique*, Les Editions de Minuit, 1980 **Chamberlain, Alan et Steele, Ross**, *Guide pratique de la communication*, éd. Didier, Paris, 1991 **Charles, René et Williame, Christine**, *La Communication orale*, éd. Nathan, 2020

Level 1 Internship:

INT.2.1 Discovery of professional life internship

Module designation	INT.2.1 discovery of professional life internship
Semester(s) in which the module is taught	between semesters 2 and 3 (summer period)
Person responsible for the module (coordinator)	Internship director
Language	French/English
Relation to curriculum	Compulsory
Teaching methods	Project – autonomous work During the internship, the intern's work is overseen by the supervisor at the hosting entity (company, research laboratory, socio-economic entity, etc.)
Workload (incl. contact hours, self-study hours)	Total workload: between 4 and 8 weeks in the hosting entity
Credit points	4 ECTS
Required and recommended prerequisites for joining the module	Depending on the theme of the project, it can cover all ENSI S1 and S2 modules. Only ENSI students who have successfully completed their first year of computer science engineering studies can join.
Module objectives / intended learning outcomes	The main objective of this internship is to discover professional life inside a company, a research laboratory or any socio-economic entity. The aim is to lead ENSI students to: i) enhance their soft and management skills in a professional environment, ii) improve their technical capacities through concrete applications within real settings and ii) practice their theoretical knowledge acquired till the first year of studies at ENSI. Competencies: C2, C3, C5, C6,C7,C11, C13
Content	– Enhance soft, interpersonal and management skills: strengthen analysis and critical thinking as well as autonomy and team work in a professional setting; develop capacities of communication and adaptation to the concrete environment of the hosting entity – Discover & analyze the professional hosting entity life (organization, structures, key processes, systems, strengths and weaknesses, …) – Solve a real problem in a production environment: contribute to the design and the implementation of a concrete solution – Write a synthetic report: boost capacities of restitution, rigorous syntheses of information, justification of choices (technical and methodological) and develop (written and oral) communication skills – Defense in front of an academic jury: develop verbal communication skills
Examination forms	A first validation is performed by the supervisor of the hosting entity who will deliver an internship letter validation or appreciation.

	The final validation of the internship takes place at ENSI, at the beginning of semester S3. The intern will have to defend her/his work during an oral presentation in front of a jury made up of at least two ENSI teachers. Such validation consists in assessing the performed work through the written synthesis report, the implemented code and the oral presentation.
Study and examination requirements	Validated internship
Reading list	McMillan, K., & Weyers, J. (2021). "How to write Dissertations and Project Reports". Bowden, J. (2008). "Writing a Report: How to prepare, write and present really effective reports", 8th Edition, How To Books.

Semester 3 Modules:

code	Title	type	Coefficients	ECTS	Total workload	Contact hours	Private study
MAT.3.1	Linear and nonlinear programming	Compulsory	3	3	75	45	30
EHA.3.1	Processors design methodology	Compulsory	3	3	75	45	30
NET.3.1	Local Area Networks	Compulsory	3	3	75	45	30
NET.3.2	Local Area Networks Management	Compulsory	1,5	1,5	37,5	22,5	15
OS.3.03	Operating Systems and concurrent programming	Compulsory	3	3	75	45	30
AP.3.1	Compilation techniques	Compulsory	1,5	1,5	37,5	22,5	15
AP.3.2	Design and Analysis of computer algorithms	Compulsory	3	3	75	45	30
SE.3.1	Software engineering	Compulsory	3	3	75	45	30
SE.3.2	Object-oriented analysis and design	Compulsory	3	3	75	45	30
AI.3.1	Artificial Intelligence & Machine Learning	Compulsory	3	3	75	45	30
BDC.3.1	Language and communication 3 (English for business communication)	Compulsory	3	3	75	45	30

MAT.3.1 Linear and nonlinear programming

Module designation	MAT.3.1 Linear and nonlinear programming
Semester(s) in which the module is taught	S3
Person responsible for the module	Nacef Elloumi
Teachers	Sarra Samaali, Fethi Kadhi
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lecture, tutorials
Workload (incl. contact hours, self-study hours)	Total workload: 75 hours Contact hours: 45 hours (30h lessons, 15h exercices) Private study: 30 hours
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	MAT.2.2 Numerical methods
Module objectives/intended learning outcomes	The concept of optimization is now well rooted as a principle underlying the analysis of many complex decision or allocation problems. It offers a certain degree of philosophical elegance that is hard to dispute, and it often offers an indispensable degree of operational simplicity. Using this optimization philosophy, one approaches a complex decision problem, involving the selection of values for a number of interrelated variables, by focusing attention on a single objective designed to quantify performance and measure the quality of the decision. This one objective is maximized (or minimized, depending on the formulation) subject to the constraints that may limit the selection of decision variable values. If a suitable single aspect of a problem can be isolated and characterized by an objective, be it profit or loss in a business setting, speed or distance in a physical problem,expected return in the environment of risky investments, or social welfare in the context of government planning, optimization may provide a suitable framework for analysis. Competencies: C1, C9
Content	1. Linear programs 1. Examples 2. Dual Linear Programs and Interpretations 3. Selected Applications of the Duality 2. The Simplex Method 1. Adjacent Basic Feasible Solutions (Extreme Points) 2. The Primal Simplex Method 3. The Dual Simplex Method 4. The Simplex Tableau Method 3. Unconstrained optimization 1. First order necessary condition 2. Second order necessary condition 3. Second order sufficient condition 4. Basic Descent Methods 1. Gradient method 2. Steepest descent method 3. Newton's Method 5. Constrained optimization 5.1 First-Order Necessary Conditions (Equality Constraints)

	5.2 Second-Order Conditions (Equality Constraints) 5.3 Inequality Constraints 5.4 Steepest Descent Projection Method
Examination forms	35%Mid-term quiz +65%Written final exam
Study and examination requirements	10/20
Reading list	David G. Luenberger and Yinyu Ye, Linear and nonlinear programming, Springer 2021

EHA.3.1 Processor design methodology

Module designation	EHA.3.1 : Processor design methodology
Semester(s) in which the module is taught	S3
Person responsible for the module (coordinator)	Karim Bouaffoura
Teaching team	Imed Ben Abdessalem, Lobna Kriaa; Montassar Ezine ; Lassaad Latrech
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson & lab work.
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 10h exercises,5h laboratory) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	EHA.1.1: Digital circuits EHA.2.1: Architecture & microprocessors
Module objectives/intended learning outcomes	● Knowledge: students ● Know the architectural design and computation using computer modelling, rendering, and digital fabrication ● know the decomposition of the µP into a Datapath and a control unit. ● know the different types of processor design (monocycle, multicycle, and pipeline) ● know RISC instruction set architecture of the processor ● Master the difference between CISC and RISC architectures ● Skills: ● Students know how to design processors and how to master assembly languages ● Competences: C5, C13.
Content	General introduction and reminder - Introduction to computer architecture - CISC vs RISC - Reminder on logical systems Chapter I: MIPS ISA Section I: Study of MIPS instructions Section II: Classification and instruction formats Chapter II: Design of arithmetic units

	Section I: Design of the arithmetic and logic unit data path Section II: Design of the multiplication and division data paths Chapter IV: Monocycle Design Section I: Data Path Design Section II: Control Unit Design Chapter IV: Multicycle Design Section I: Data Path Design Section II: Control Unit Design Chapter V Pipeline Design Section I: Introduction and notions of pipeline execution Section II: Hazard Problems and Their Resolution Section III: Pipeline Data Path Design
Examination forms	35% continuous evaluation + 65% written exam
Study and examination requirements	10/20
Reading list	- Hennessy, J. L., & Patterson, D. A. (2021). *Computer organization and design RISC-V edition: The hardware software interface.* - Patterson, D. A., & Hennessy, J. L. (2003). *Architecture des ordinateurs, Une approche quantitative* (3rd ed.). Vuibert. (1194 pages) - Tanenbaum, A. (2005). *Architecture de l'ordinateur* (5th ed.). Pearson France. (748 pages) - Lazard, E. (2006). *Architecture de l'ordinateur*. Pearson Education. (213 pages)

NET.3.1 Local Area Networks

Module designation	*NET.3.1*
Semester(s) in which the module is taught	*S3*
Person responsible for the module	*Ahmed Elleuch*
Teachers team	*Hanen Idoudi, Maher Sellami, Naouel Grati, Maroua Bakri,Leila Nasraoui*
Language	*French*
Relation to curriculum	*Compulsory*
Teaching methods	*Lesson, exercices.*
Workload (incl. contact hours, self-study hours)	*(Estimated) Total workload: 75h00* *Contact hours: 45h (30h lesson, 15h exercises)* *Private study including examination preparation, specified in hours: 30h*
Credit points	*3 ECTS*
Required and recommended prerequisites for joining the module	*NET.2.1 Digital Transmission*

Module objectives/intended learning outcomes	The purpose of this course is to study the fundamental concepts of Local Area Networks (LANs), their architecture, the underlying protocols and how to interconnect them. At the end of the course, the students will : - Identify the characteristics that make LANs different from other types of networks. - Compare and contrast LAN topologies, transmission mediums and transmission techniques and consequently identify the current trends. - Analyze and evaluate various medium access methods. - Apply OSI and IEEE 802 models to LAN architecture. - Understand IEEE 802.3 and IEEE 802.11 standards. - Understand how the Ethernet has evolved from its traditional version into Fast Ethernet, Gigabit Ethernet … - Understand general guidance on structured LAN cabling for intelligent buildings. - Show clear understanding behind interconnecting LANs and how bridge filtering and forwarding works. - Master IPv4 addressing and the interconnection of local networks through routers. *Outcomes: C1.*
Content	Chapter I – Local Area Networks : Basic Concepts and Fundamentals - Topologies - Transmission Mediums - Transmission Techniques - Medium Access Methods Chapter II – IEEE 802 LAN Standards - IEEE 802 Architecture - MAC Address Format - Logical Link Control - IEEE 802.3 Family of Standards - IEEE 802.11 Family of Standards Chapter III – LAN interconnection - Connectivity Devices : Repeaters, Hubs, Bridges, Switches, Routers and Gateways - Transparent Bridging - Spanning Tree Algorithm - VLANs Chapter III – Structured LAN Cabling - General Overview - Horizontal Cabling System - Vertical (Backbone) Cabling System - Building a Structured Cabling System: Connectors, Cables, Patch Panels, Copper Patch Cords Fiber Optic Splice Cassettes, Racks Cabinets … - General Installation Recommendations Chapter V – TCP/IP networks - TCP/IP Architecture - IP Addressing and Subnetting - IP Routing - Network Address Translation

	- DHCP - DNS
Examination forms	*35% continuous assessment (tests and mid-term exam) + 65% written exam*
Study and examination requirements	*10/20*
Reading list	- Stallings, W. (2014). *Data and Computer Communications (10th ed.). Pearson Education. (917 pages).* - Toutain, L. (2003). *Réseaux locaux et Internet: Des protocoles à l'interconnexion. Hermes Science Publications. (844 pages).*

NET 3.2 LAN Management

Module designation	**NET 3.2** LAN Management
Semester(s) in which the module is taught	*S3*
Person responsible for the module	*Ahmed Elleuch*
Teachers team	*Hanen Idoudi, Maher Sellami, Naouel Grati, Maroua Bakri,Leila Nasraoui, Rihab Bousssada*
Language	*French*
Relation to curriculum	*Compulsory*
Teaching methods	*Lesson, lab works*
Workload (incl. contact hours, self-study hours)	*(Estimated) Total workload: 37.5h* *Contact hours : 22.5h (5h lesson, 17.5h laboratory)* *Private study including examination preparation, specified in hours: 15h*
Credit points	*1.5 ECTS*
Required and recommended prerequisites for joining the module	*NET.3.1 Local Area Networks* *OS.2.1 Introduction to operating systems and Unix environment*
Module objectives/intended learning outcomes	The purpose of this course is to develop practical skills to install, configure and troubleshoot hardware and software LAN components including switches, routers and several network services using Linux, Microsoft and Cisco Shell Commands. At the end of the course, the students will : - Configure Spanning Tree, VLANs and trunking on Cisco switches. - Deploy, configure and troubleshoot a TCP/IP network. - Configure and verify Squid Proxy, SNAT/DNAT and filtering operations using IPTABLES. - Configure and verify DHCP and DNS services. *Outcomes: C1.*
Content	I– Deploying IP Networks under Linux and MS Windows ▪ IP Addresses ▪ Static Routing ▪ Network Troubleshooting II– Deploying IP Networks under IOS CISCO ▪ IP Addresses ▪ Static Routing ▪ Network Troubleshooting III–Deploying DHCP and DNS Services under Linux et MS Windows

	▪ DHCP Client and Server ▪ DHCP Relay ▪ DNS Client and Server, DDNS IV– Deploying Squid and IPTABLES under Linux ▪ Configuring Squid as non Transparent and Transparent Proxy ▪ Configuring the Squid Authentication ▪ Configuring Squid Caches ▪ IPTABLES Filtering ▪ SNAT/DNAT with IPTAPLES V – Deploying LAN Networks under IOS Cisco ▪ Trunking ▪ Configuring VLAN ▪ Configuring Spanning Tree
Examination forms	50% continuous evaluation + 50% project evaluation
Study and examination requirements	*10/20*
Reading list	- Linux Network Administrator's Guide. (2000). O'Reilly Media. (506 pages). - Odom, W. (2020). CCNA 200-301 Official Cert Guide, Volume 1. Cisco Press.

OS.3.3 Operating Systems and concurrent programming

Module designation	0S.3.1 Operating Systems and Concurrent Programming
Semester(s) in which the module is taught	S3
Person responsible for the module (coordinator)	Faïza NAJJAR
Teaching team	Nessrine Chakchouk, Houcine Elhedhili, Chiraz Houaidia, & Mehrez Essafi, Rihab Boussada
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lessons, lab works, exercises & mini-project
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h lab works) Private study: 30h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	C programming (AP.1.3); Introduction to operating systems and Unix (OS.2.1)
Module objectives/intended learning outcomes	Objectives: Where there are processors, there are operating systems. This teaching module should lead to a good understanding of the functionalities, mechanisms and algorithms involved in multitasking and multithreaded operating systems. It should also promote their efficient use with system and multithreaded programming. Intended learning outcomes: C1, C7, C8
Content	CHAP. 1. PROCESS & THREADS MANAGEMENT (3 weeks) ● Introductions: Terminology and basic principles of operating systems ● Process concepts (Process switching, process states, …)

	● Process control bloc --PCB ● Thread Concepts (Definition of threads, processes vs. Threads LAB: SYSTEM PROGRAMMING (LINUX) ● Linux processes (ps, top, …). ● Process creation (fork, wait, exec, …) ● Posix threads (pthread_create, pthread_join, …) CHAP. 2. CPU SCHEDULING (2 weeks) ● Basic concepts: scheduler, dispatcher ● Scheduling objectives/criteria ● Types of scheduling ● Scheduling algorithms; non preemptive/preemptive (FCFS, SJF, RR, SRTF…) ● Scheduling hierarchy ● Thread Scheduling HOMEWORK : exercises on archive exams CHAP. 3. PROCESS SYNCHRONIZATION AND COMMUNICATION (4 weeks) ● Critical section problem ● Mechanisms of synchronization (locks, Semaphores, monitors, …). ● Standards synchronization problems (RDV, producer/consumer; readers/writers) ● Posix Threads IPC (mutex, sem, condition, …). ● Communication with messages –pipe Unix (pipe, FIFO) ● Homework exercises & Lab. Unix pipe (Programming) ct: Thread synchronization (mutex, sem, conditional variables, …). CHAP. 4. MEMORY MANAGEMENT AND VIRTUAL MEMORY (3 weeks) ● Fundamental concepts, storage-device hierarchy (pyramid of memories) ● Static/dynamic allocation ● Allocation algorithms (first fit, best fit, worst fit) ● Segmentation/ paging/ swapping ● Virtual memory management ● Addressing mechanisms ● Replacement algorithms (FIFO, optimal, LRU/LFU, …) RK : exercises on memory management CHAP. 5. DEADLOCK & RECAP (1 week) ● Notion of deadlock (constraints), graph presentation ● Detection, correction, prevention, avoidance ● Recap and summary & Cutting edge IT ● Correction of midterm exam ● Classroom exercises
Examination forms	50% continuous evaluation (20% CW + 30% Midterm Exam) + 50% Final Exam
Study and examination requirements	10/20
Reading list	- Stallings, W. (2018). *Operating Systems: Internals and Design Principles* (9th ed.). Pearson. ISBN 13: 978-0-13467095-9. - Silberschatz, A., Galvin, P., & Gagne, G. (2012). *Operating Systems Concepts* (9th ed.). John Wiley & Sons, Inc. ISBN-13: 978-1118063330. - Tanenbaum, A., & Bos, H. (2014). *Modern Operating Systems* (4th ed.). Pearson. ISBN-13: 978-0133591620.

AP.3.1 Compilation techniques

Module designation	AP.3.1. Compilation Techniques
Semester(s) in which the module is taught	S3
Person responsible for the module	Leila Ben Ayed
Team	Hatem Aouadi
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, project (B4free and NuSMV Tools)
Workload (incl. contact hours, self-study hours)	Total workload: 37.5h Contact hours: 22.5h (12h Lessons, 10.5h Exercices and Project with C language) private study: 15h
Credit points	1,5 ECTS
Required and recommended prerequisites for joining the module	Automata Theory and Languages (AP.2.3)
Module objectives/intended learning outcomes	This course extends the knowledge acquired in automate theory and languages course to become able to develop a compilers. Compilers are important system software components: they are intimately interconnected with architecture, systems, programming methodology, and language design Compilers include many applications of theory to practice: scanning, parsing, static analysis, instruction selection Many practical applications have embedded languages: commands, macros, formatting tags Many applications have input formats that look like languages: Matlab, Mathematica Writing a compiler exposes practical algorithmic & engineering issues: approximating hard problems; efficiency & scalability. Knowledge: ● Lexical analysis ● Different techniques for syntactical analysis ● Semantic analysis ● Translation into intermediate code for interpretation Competencies: C1, C2.
Content	Lesson I (03h). Introduction to compilation ● Compilation steps ● Backus-Naur form Grammar ● Compilation in one pass Lesson 2 (06h). Syntactical analyses ● Recursive analyses ● Predictive recursive analysis ● Predictive non recursive analyses Lesson 3 (3h) Lexical analyses ● Regular expression and lex (or Flex) ● Automata and lexical analysis ● Intermediate table Lesson 4 (3h) Semantic analysis ● Formal Specification of semantic control ● Integration of semantic control Lesson 5 (4h 30mn) Transformation into intermediate code ● Specification of transformation rools ● Integration of transformation rools Lesson 6 (3h) Interpretation

	• Interpretation of intermediate code • Project Presentation
Examination forms	35% Continues evaluation + 65% Written exam
Study and examination requirements	10/20
Reading list	- Hopcroft, J., Motwani, R., & Ullman, J. D. (2001). *Introduction to Automata Theory, Languages, and Computation*. Addison-Wesley. - Aho, A., Sethi, R., & Ullman, J. D. (1991). *Compilateurs Principes, Techniques et Outils*. InterEditions.

AP.3.2 Design and analysis of computer algorithms

Module designation	AP.3.2 Design and analysis of computer algorithms
Semester(s) in which the module is taught	S3
Person responsible for the module	Anja Habacha
Teachers	Walid Sadfi, Rihab Said
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, projects, practical work
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h projects) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	AI.1.1 Formal Logic AP.1.2 Algorithmic and data structure AP.2.3 : Automata Theory & language
Module objectives/intended learning outcomes	Students Have a general overview of • Complexity of algorithms • Complexity of Problems • NP-complete problem • Some advanced Algorithmic paradigms • Some advanced data structure intended learning outcomes: C1, C9
Content	The description of the contents should clearly indicate the weighting of the content and the level. Chapter 1: Introduction 1. Module objectives 2. Asymptotic notation Chapter 2: Complexity of algorithm 1. Introduction 2. Iterative algorithm 3. Recursive algorithm Chapter 3: Complexity of problem 1. Introduction 2. Complexity of Turing Machine 3. Complexity of problem (definition) 4. P an NP problem 5. NP-Complete problems 6. Some polynomial transformation Chapter 4: Some algorithmic strategies 1. Introduction

	2. Divide and conquer 3. Greedy algorithm 4. Branch & Bound strategy 5. Dynamic programming Chapter 5: Some advanced data structure 1. Balanced tree 2. AVL-tree 3. Bi-colour Tree
Examination forms	35% continuous assessment + 65% written exam
Study and examination requirements	10/20
Reading list	Perifel, S. (2014). *Complexité algorithmique*. Ellipses. Garey, M. R., & Johnson, D. S. (1983). *Computers and Intractability: A Guide to the Theory of NP-Completeness*. W. H. Freeman. Horowitz, E., & Sahni, S. (1979). *Fundamentals of Computer Algorithms*. Pitman. Papadimitriou, C. H. (1993). *Computational Complexity*. Addison-Wesley Publishing Company. Ullman, J. D., Aho, A. V., & Hopcroft, J. E. (1974). *The Design and Analysis of Computer Algorithms*. Addison-Wesley. Cormen, T. H., Leiserson, C. E., & Rivest, R. L. (1990). *Introduction à l'algorithmique*. Dunod.

SE.3.1 Software engineering

Module designation	SE.3.1 Software engineering
Semester(s) in which the module is taught	S3
Person responsible for the module	Nesrine Ben Yahia
Teachers	Imtiez Fliss ; Aroua Hdhili ; Fadoua Ouamani ; Yemna Sayeb, Amina Jarraya; Narjes Bellamine
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, seminar, projects, workshops
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h projects) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	AP.2.1 Object oriented Programming AP.2.2 Web Technologies DAT.1.1 Data base & SGBD
Module objectives/intended learning outcomes	Students Have a general overview of software engineering and understand the added value of software engineering Students know software development processes using semi-formal approaches and know how to choose and apply these processes Students Know the different steps of software development (analysis, design, implementation, test, integration) and are able to choose and apply different techniques for each step Competences: C1, C2, C3, C5, C8, C9, C13
Content	CHAPTER 1: INTRODUCTION TO SOFTWARE ENGINEERING 1. Software 2. Software Engineering (SE) CHAPTER 2: SOFTWARE DEVELOMENT PROCESSES

	1. Introduction 2. Definitions 3. Software Life cycle 4. Software development Processes models CHAPTER 3: REQUIREMENT ANALYSIS 1. Requirements description a. Issues b. Functional requirements c. Non-Functional requirements d. Domain requirements e. Example of IEEE standard for requirements description 2. Specification a. Modelling b. Specification Styles CHAPTER 4: DESIGN 1. Introduction 2. Design Overview 3. Principles of design 4. Design quality 5. Architectural design a. Definitions b. Choosing an architecture c. architectural patterns CHAPTER 5: TESTING THE SOFTWARE 1. Introduction 2. Objectives of the tests 3. Characteristics of a "good" test 4. The different test methods 5. Black box testing a. Partitional analysis (equivalence classes) b. Limit tests 6. White box testing a. Principle b. Control flow graph c. Coverage criteria d. Cyclomatic complexity 7. Criteria for stopping tests 8. Automatic tests
Examination forms	35% continuous assessment (project and mid-term exam) + 65% written exam
Study and examination requirements	10/20
Reading list	- Sommerville, I. (2020). Engineering Software Products. Pearson. - Sommerville, I. (2015). Software Engineering (10th ed.). Pearson. (816 pages) - Pressman, R. S. (2015). Software Engineering: A Practitioner's Approach (8th ed.). McGraw Hill. (976 pages) - Kim, G., Debois, P., Willis, J., Humble, J., & Allspaw, J. (2016). The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations. IT Revolution Press. (480 pages)

SE.3.2 Object-oriented analysis and design

Module designation	SE.3.2 Object-oriented analysis and design
Semester(s) in which the module is taught	S3
Person responsible for the module	Imtiez Fliss
Teachers	Nesrine Ben Yahia ; Aroua Hdhili ; Fadoua Ouamani ; Yemna Sayeb, Amina Jarraya; Narjes Bellamine
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, seminar, projects, workshops
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h projects) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	AP.2.1 Object oriented Programming AP.2.2 Web Technologies DAT.1.1 Data base & SGBD
Module objectives/intended learning outcomes	Students Have a general overview of Unified Modelling Language (UML) Students know the different diagrams of UML2.5 Students learn object modelling Students Know and use design patterns Competences: C1, C2, C3, C5, C8, C9, C13
Content	The description of the contents should clearly indicate the weighting of the content and the level. Chapter 1: Introduction 1. Object orientation 2. Importance and interest of modeling 3. The UML modeling language 4. Complete chain of a modeling approach from the need to the code Chapter 2: Analysis diagrams 1. Introduction 2. Requirements modeling 3. Structural modeling: analysis 4. Dynamic modeling: analysis Chapter 3: Architectural Design Diagrams 1. Introduction 2. Views of a software architecture 3. Package Diagram 4. Component diagram 5. Deployment diagram Chapter 4: Detailed Design Diagrams 1. Introduction 2. Concepts Underlying Detailed Design 3. Structural modeling: design 4. Dynamic modeling: design Chapter 5: Design Patterns 1. Introduction: Background 2. Presentation of design patterns 3. Classification of patterns 4. Design patterns of creation 5. Structural design patterns 6. Behavioral Design Patterns Chapter 6: Summary Case Studies
Examination forms	35% continuous assessment + 65% written exam
Study and examination requirements	10/20

Reading list	- Fowler, M. (2004). UML Distilled: A Brief Guide to the Standard Object Modeling Language (3rd ed.). Addison-Wesley Professional. - BERSINI, H. (2004). L'orienté objet Cours et exercices en UML2 avec Phyton, Java, C# et C++. EYROLLES. Bibliothèque ENSI (A-824.3). - Larman, C. (2005). UML 2 et les Design Patterns - (3ème édition). PEARSON. (850 pages).

AI.3.1 Artificial Intelligence & Machine Learning

Module designation	AI.3.1 Artificial Intelligence and Machine learning
Semester(s) in which the module is taught	S3
Person responsible for the module (coordinator)	Moncef TAGINA
Team	Chiraz Zribi, Amal Tarifa
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, lab works, projects.
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h projects) Private study: 30h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	MAT.1.1, M.1.2, Algorithmics and data structures
Module objectives/intended learning outcomes	In terms of Knowledge: This course introduces the foundations artificial intelligence and machine learning. The first objective is to allow problem solving using artificial intelligence algorithms by searching methods (well-defined problems and solutions, formulating problem, real-world problems). The second objective is to provide Its objective is to make the theoretical concepts understood and to provide a good mastery of the different algorithms to implement them in academic situations and above all to be able to distinguish the situations favourable for the application of each approach studied. Competences: C1, C2, C4, C9.
Content	Chapter 1: Overview of Artificial Intelligence foundations (6h) ● Introduction to AI Algorithms: Foundations, goal, types, applications, and problems solved using classification, regression, and clustering ● Introduction to Machine learning Chapter 2: Search Algorithms for problem solving (12h) ● Uninformed search methods ● Breadth-first search ● Uniform-cost search ● Depth-first search ● Iterative deepening search ● Bidirectional search Informed search methods ● Generic best-first search ● A* search ● Recursive best-first search (RBFS)

	● Simplified memory-bounded A* (SMA*) Chapter 3: Supervised learning (9 h) ● Introduction and definitions ● Biological neural and artificial neural ● Deterministic Perceptron ● Probabilistic Perceptron ● Multi-Layer Perceptron and error backpropagation ● KNN algorithm ● Practical: Introductory example (Linear regression, Gradient descent) ● Practical: KNN & Decision trees Chapter 4 Unsupervised Learning (9 h) ● Introduction and definitions ● Agglomeration approaches ● Distribution approaches ● Model-based approaches ● Density approaches ● Practical: K-means Chapter5 Reinforcement learning (9h) ● Introduction and definitions ● Markov decision process ● Approaches for exploration and exploitation ● Q-learning algorithm ● Practical: Q-learning with Python
Examination forms	35% continuous assessment + 65% written exam
Study and examination requirements	10/20
Reading list	- Russell, S., & Norvig, P. (2020). Artificial Intelligence: A Modern Approach (4th USA edition). Pearson. (1136 pages) - Cornuéjols, A., Miclet, L., & Barra, V. (2018). Apprentissage Artificiel: Deep Learning, Concepts et Algorithmes. Eyrolles Algorithmes. - Cornuéjols, A., Miclet, L., & Barra, V. (2021). Apprentissage Artificiel: Concepts et Algorithmes - De Bayes et Hume au Deep Learning. Collection Algorithmes.

BDC.3.1 Language and communication 3: English for Business Communication

Module designation	BDC.3.1 Language and communication 3: English For Business communication
Semester(s) in which the module is taught	S3 or S4
Person responsible for the module	Faycel DHAKHLAOUI
Teaching team	Hanen JAYARI
Language	English
Relation to curriculum	Compulsory
Teaching methods	Lecture, project, group work,
Workload (incl. contact hours, self-study hours)	Total workload:75h Contact hours :45h (15h lessons, 30h practice) Private study including examination preparation:30h
Credit points	3ECTS
Required and recommended	General English intermediate level

prerequisites for joining the module	
Module objectives/intended learning outcomes	-develop techniques in two areas of communication: presenting information and participating in meetings. - develop knowledge of the language used in these two areas and also to develop knowledge in the language used for job interview, job application and other business issues - Develop communicative skills of preparing, presenting and assessing projects. Competences: C11
Content	UNIT 1 : PRESENTATION Lesson 1: Planning 1- Pre-reading : Commenting on pictures 2- Reading : When Incompetence is tantamount to Fraud 3- Vocabulary : Introducing a presentation 4- Speaking : Making an introduction Lesson 2 : Visual Aids 1- Speaking : Using visual aids : Advantages and warnings 2- Vocabulary : Describing trends 3- Speaking : Describing a graph 4- Vocabulary Lesson 3 : The middle of a Presentation 1- Pre-reading : The relationship with the audience 2- Reading : Text ' You're lost if you lose your audience' 3- Writing : Sequencing : linking ideas 4- Speaking : Listing Information Lesson 4 : The End of a Presentation 1- Pre-reading : The conclusion 2- Reading : Open for questions : The silent disaster 3- Speaking : Role play : Question and discussion UNIT TWO : APPLYING FOR A JOB Lesson 5 : Employment practices 1- Pre-reading : Discussion: Looks for interviews 2- Reading : LOOKS : Appearance Counts With Many Managers 3- Vocabulary : Matching exercise 4- Grammar : Present simple and present continuous Lesson 6 : Recruitment techniques 1- Pre-reading : Selecting a job 2- Reading : Recruitments across the Channel 3- Speaking : How to choose one's job ? Lesson 7 : Applying for a job 1- Grammar : Tenses : present simple and present continuous 2- Reading : 'Prefer a camping trip to a cocktail party' 3- Writing : Writing a letter of application Lesson 8 : Sitting for a job interview Language: word formation Reading: Job Interviews: Tips to remember Speaking: Practice: sitting for a job interview Unit 3: Successful businesses Lesson 9 : Successful meetings Vocabulary : The language of meetings Speaking : Group work : Holding a meeting Lesson 10: Outsourcing Vocabulary: Know-how transfer Reading: India's Outsourcing Woes Language: Tenses review Lesson 11: Successful Careers Reading: Is there a Gene for Business

	Language: word formation Writing: the argumentative essay
Examination forms	50% continuous evaluation (oral presentation, mini project and essay writing); 50% written exam
Study and examination requirements	10/20
Reading list	- Cotton, D., Falvey, D., & Kent, S. (2006). Market Leader. Pearson Education Limited. (176 pages) - Eaton, D., Nanson, A., & Yening, H. (1999). Advanced Master Class. Oxford: Oxford University Press. - Richards, J. (1996). Changes: English for International Communication. Cambridge: Cambridge University Press. - Sweeney, S. (1997). English for Business Communication. Cambridge: Cambridge University Press.

Semester 4 Modules:

code	Title	type	Coefficients	ECTS	Total workload	Contact hours	Private study
MAT.4.1	Stochastic processes	Compulsory	3	3	75	45	30
EHA.4.1	Introduction to Embedded Systems	Compulsory	3	3	75	45	30
NET.4.1	Computer networks	Compulsory	3	3	75	45	30
SE.4.1	Formal development methods	Compulsory	3	3	75	45	30
SE.4.2	Software Architectures	Compulsory	3	3	75	45	30
SEC.4.1	Cybersecurity & Cryptography	Compulsory	3	3	75	45	30
FIN.4.1	Introduction to financial markets	Compulsory	3	3	75	45	30
INT.4.1	Design and development project	Compulsory	3	3	75	45	30
BDC.4.1	introduction to Entrepreneurship and innovation	Compulsory	3	3	75	45	30
BDC.4.2	Language and communication 4 (Communication Techniques)	Compulsory	3	3	75	45	30

MAT.4.1 Stochastic processes

Module designation	MAT.4.1 Stochastic Processes
Semester(s) in which the module is taught	S4
Person responsible for the module	Fethi Kadhi
Team	Faten Maddouri
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lessons, Lab, Projects.
Workload (incl. contact hours, self-study hours)	Total workload: 75 h Contact hours: 45 h (30h lessons, 15h exercices) Private study: 30 h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	MAT.1.1 Probability and statistics
Module objectives/intended learning outcomes	The objective of this course is the study of the main stochastic processes. More specifically, Poisson processes (p.p), discrete-time Markov chains (CMTD), continuous-time Markov chains (CMTC), waiting phenomena, birth and death processes , Gaussian processes (p.g), Brownian motions (mb), stochastic integrals, martingales, stopping times. A focus of this course is the use of simulation. I have chosen to use the popular statistical freeware R, which is an accessible interactive computing environment. The use of simulation, important in its own right for applied work and mathematical research, is a powerful pedagogical tool for making theoretical concepts come alive with practical, hands-on demonstrations. Competencies: C1, C9
Content	1. Generalities 1. Definition and examples 2. Classification 3. Stationarity 4. Memoryless property 2. Poisson Processes 1. Definition 2. Characterisations 3. Decomposition 4. Superposition 3. Discrete Time Markov Chain 1. Definition and examples 2. Stochastic matrices 3. Classification of states 4. Ergodic theorem in DTMC 4. Continuous Time Markov Chain 1. Definition and examples 2. Instantaneous distribution 3. Stationary distribution 4. birth and death processes 5. Brownian motion 1. Definition 2. Brownian motion with drift 3. Geometric Brownian motion

	4. BM as Gaussian processes 6. Stochastic Integrals 1. Ito integrals 2. Stochastic differential equations
Examination forms	35% continuous evaluation + 65% Written final exam
Study and examination requirements	10/20
Reading list	- Dobrow, R. P. (2016). Introduction to Stochastic Processes with R. Wiley. (502 pages) - Hassler, U. (2015). Stochastic Processes and Calculus: An Elementary Introduction with Applications. Springer. - Leszek, G., & Vidyadhar, M. (2015). Stochastic Analysis for Gaussian Random Processes and Fields: With Applications. CRC Press. - Pierre, D., Jacques, J., & Raimondo, M. (2015). Basic Stochastic Processes. Wiley-ISTE. - Ross, S. (2014). Introduction to Probability Models (11th ed.). Academic Press. - Florescu, I. (2014). Probability and Stochastic Processes. Wiley. - Lefebvre, M. (Year). Applied Stochastic Processes. Springer-Verlag. - Baynat, B. (2000). Théorie des Files d'Attente. Hermess Science Europe.

EHA.4.1 Introduction to Embedded Systems

Module designation	EHA.4.1: Introduction to Embedded Systems
Semester(s) in which the module is taught	S4
Person responsible for the module (coordinator)	Lobna Kriaa
Teaching team	Imed Ben Abdessalem ; Moez Soltani ; Lassaad Latrech; Chadlia Jerad, Karim Bouaffoura
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson & lab works.
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact Hours: 45h (20h lessons, 5h exercises, 20h laboratory) Private study: 30h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	EHA.1.1: Digital circuits EHA.2.1: Architecture & microprocessors EHA.3.1: Processor methodology design AP.1.2: Algorithmics & data structure AP.1.3: Advanced C programming
Module objectives/intended learning outcomes	● Knowledge: students ● Identify the characteristics and specificities, structure and operation of embedded systems ● Understand the methods of specification and design of embedded systems ● Learn the programming of microcontrollers ● Know the architectural design using VHDL and FPGA circuits ● Master the difference between software and hardware design ● Skills: Students know ● how to read datasheets ● How to discover existing libraries and identify their use ● How to use EDA tools (Quartus, VIVADO, Keil, IAR, etc). ● The cross-compilation mechanism

	● Competences: C5, C13.
Content	General Introduction - Definition of an embedded system - Design constraints of embedded systems - Embedded system design - Software design - Hardware design - Mixed design Chapter I: FPGA Characteristics and Programming Section I: FPGA - Definition of an FPGA - Components of an FPGA - Design flow for FPGA Section II: VHDL hardware modelling language - VHDL Syntax - VHDL hardware description Chapter II: CASE Study: The STM32 family of microcontrollers Section I : Study of the processor characteristics (for example Cortex M3 (CM3) ● Memory alignment ● Bit Banding ● Interrupt management Section II: Microcontrollers Programming: ● Software stack model such as CMSIS model ● Programming Characteristics (libraries and dependencies Chapter IV : Programming of peripherals Section I: GPIO - Study of the characteristics of GPIOs - Labs Section II: External Interruption (EXTI Example) - Study of the characteristics of the EXTI - Labs Section III: Systick Timer - Study of the characteristics of the Systick - Labs Section IV: ADC - Study of the characteristics of the ADC - Labs Section V: UART - Study of the characteristics of the UART - Labs
Examination forms	35% continuous evaluation + 65% written exam
Study and examination requirements	10/20
Reading list	- Ashenden, P. J., & Lewis, J. (2008). The Designer's Guide to VHDL (3rd ed.). Elsevier. - Schmid, A., & Holzer, R. (2022). Microcontrôleurs Théorie et pratique de l'AVR. Presses Polytechniques et Universitaires Romandes (PPUR). (546 pages) - STM. (2016, November). Product Datasheet STM32F100x468B-B Low & medium-density value line, advanced ARM®-based 32-bit MCU with 16 to 128 KB Flash, 12 timers, ADC, DAC & 8 comm interfaces.

NET.4.1 Computer networks

Module designation	NET.4.1 Computer networks
Semester(s) in which the module is taught	S4
Person responsible for the module	Ahmed Elleuch
Teachers team	Chiraz Houaidia, Nesrine Chakchouk, Naouel Grati, Mohamed Houcine Hdhili, Hanen Idoudi
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson
Workload (incl. contact hours, self-study hours)	Total workload:75h Contact hours: 45h (30h lesson, 15h exercises) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	NET.3.1 Local Area Networks NET 3.2 LAN Management NET.2.1 Digital Transmission
Module objectives/intended learning outcomes	Understand the basic concepts and fundamentals of modern computer networks with a focus on the TCP/IP protocol suite. The traditional modular OSI layered approach is used only as starting point reference and not the actual organizational model. At the end of the course, the students will : ● Be familiar with underlying network technologies, their physical and data link layers, packet, cell and circuit switching and how it is possible to interconnect multiple networks to build the Internet. ● Show clear understanding of the network and transport layer protocols and how they work together to provide a cumulative reliable end-to-end communication service over an unreliable network. ● Understand how different protocol elements like error detection/correction, data fragmentation, flow and congestion control may be achieved at different layers and not necessarily as planned previously in the OSI model. ● Understand routing principles and algorithms. ● Be prepared for advanced courses in computer networking. Competences: C1, C13.
Content	PART ONE – The Basics of Computer Networking 1. Introductory Concepts Classification Taxonomy Network Topologies Network Models OSI Model Internet Model Wide area Networks Switching techniques: Circuit Switching, Packet Switching, Virtual Circuit and Datagram Example Networks and their Reference Model Building an Internetwork Network performance Performance Measurements Bandwidth Delay Product

	Application Performance Needs PART TWO – The Network Access Layer 1. The Physical Layer Analog and Digital Transmission Data Encoding Techniques Error Detection and Correction Parallel and Serial Transmission Synchronous and Asynchronous Transmission Digital Multiplexing Hierarchies Using Telephone for Data Transmission The Data Link Layer Frame Structure Flow and Error Control WAN Data Link Protocols: PPP, Frame relay and ATM PART THREE – The Network Layer 1. Internetworking Internetworking Concept and Principles Internetworking with IP Datagram protocols (IPv4, IPv6) Addressing Address Translation Error Reporting (ICMP) Fragmentation Routing Interior Routing Protocols: Distance Vector Routing (RIP) and Link State Routing (OSPF) Inter-domain Routing (BGP) PART FOUR – The Transport Layer 1. TCP and UDP Services Client/Server Paradigm Connectionless and Connection-Oriented Service Reliable and Unreliable Services TCP and UDP port Addressing End-to-end protocols UDP Header TCP Header TCP Connection Establishment and Termination TCP Flow Control TCP Congestion Control TCP Timeout and Retransmission TCP Timers
Examination forms	35% continuous assessment (tests and mid-term exam) + 65% written exam
Study and examination requirements	10/20
Reading list	- Stallings, W. (2007). Data and Computer Communications (10th ed.). Pearson Education. (917 pages) - Comer, D. (2005). Internetworking with TCP/IP Principles, Protocols and Architectures (5th ed.). Pearson Education. (688 pages) - Tanenbaum, A. (2010). Computer Networks (5th ed.). Pearson Education. (960 pages)

SE.4.1 Formal development methods

Module designation	SE.4.1. Formal Development Methods
Semester(s) in which the module is taught	S4
Person responsible for the module	Leila Ben Ayed
Team	Fadoua Ouamani, Hassen Gharbi
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, project (B4free and NuSMV Tools)
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours 45h (30h Lessons, 15h Exercices and Project) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	IA.1.1. Formal Logic AP.1.1 Automata Theory and Languages AP.3.2 Compilation Techniques
Module objectives/intended learning outcomes	The objective of this Lesson is to allow students to be able to ensure safety requirements of developed systems in development process. Students will be able to develop models, specify rquirements and verify required properties or give bed behaviour for the test team. Knowledge: ● Design models with the B method ● Refining models ● Proof obligation calculus ● Specifying properties with linear and tree temporal logics ● Using model checking technique for the verification ● Competencies: C1, C2, C3.
<u>Content</u>	Lesson I (06h). Introduction to formal specification and verification ● Preliminary: Formal systems, automata and model theory, dynamic Semantics ● Specification and Formal Verifcaton ● Theorem proving and Model checking ● Why and how we use formel methods in software development ● Case study ● Introduction to behavior (automatae et execution tree), invariant and proof ● Required properties Lesson 2 (12h) Formal development in B AMN (abstract machine Notation) ● Abstract machine, static, dynamic parts and invariant ; ● Specification of Invariant (required safety or liveness property); ● Proof obligation; ● Generalized substitution ; ● Proof of coherence (Atelier B & B4free); ● Listes et les sequences. Lesson 3 (3h) The event B ● The event B Model; ● Events modeling ; ● Invariant specification ;

	● Proof of coherence in event B ; ● Applications : Time out and et Packet Sorter. Lesson 4 (6h) Refinement process ● Raffinement of preconditions, events and postconditions ; ● Refinement Invariant ; ● Proof of refinement ; ● Case study with the tool B4free ; ● Implementation. Lesson 5 (3h) Temporal logic and model checking ● Behavior modeling and temporal logic ; ● The Kripke Structure ; ● Execution paths (tree and properties over states) ; ● Safety, liveness and fairness properties ; ● Exemples of logic for the specification of required properties ; ● Vérification of temporal formulae over a Kripke structure. Lesson 6 (6h) The Propositional Linear Temporal Logic PLTL and the Model Checker SPIN ● Linear behavior modeling ; ● Temporal operators and PLTL syntax ● The Buchi automaton for the et specification of temporal properties ; ● The semantic of PLTL ; ● Composition of Automata for the verification; ● Verification with SPIN - Case study. Lesson 7 (8h) The Computation Tree Logic CTL and the model checker NuSMV ● Exemple of model and properties specification in CTL ; ● Path quantifiers and the syntax of CTL ; ● The semantic of CTL ; ● The Fixed Point Theorem ; ● Satisfiability of a CTL formula over a state ; ● Verification of CTL formulae ; ● The symbolic model checker NuSMV ;
Examination forms	35% Continues evaluation + 65% Written exam
Study and examination requirements	10/20
Reading list	- Abrial, J.-R. (1996). The B-Book: Assigning Programs to Meanings. Cambridge University Press. - Harel, D., & Politi, M. (1998). Modeling Reactive Systems with Statecharts: The Statemate Approach. McGraw-Hill. - Manna, Z., & Pnueli, A. (1992). The Temporal Logic of Reactive and Concurrent Systems: Specification. Springer. - Lano, K. (1996). The B Language and Method: A Guide to Practical Formal Development. Springer. - Schnoebelen, P. (1999). Vérification de Logiciels: Techniques et Outils du Model-Checking. Vuibert. - Baier, C., & Katoen, J.-P. (2008). Principles of Model-Checking. MIT Press.

SE.4.2 Software Architecture

Module designation	SE.4.2 Software Architecture
Semester(s) in which the module is taught	S4
Person responsible for the module	Nesrine Ben Yahia
Teachers	Aroua Hdhili ; Amina Jerraya, Marouane Chaieb
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, seminar, projects, workshops
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (30h lessons, 15h projects) Private study: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	AP.2.1 Object oriented Programming AP.2.2 Web Technologies DAT.2.1 Data base & SGBD SE.3.1 Software Engineering SE.3.2 Object Oriented Analysis & Design
Module objectives/intended learning outcomes	Students Have a general overview of software architecture and architectural paradigms Students understand the different types of architecture and the profession of architect Students have an overview of the main architectural styles Students use and apply some architectural styles and patterns Students learn how to evaluate an architecture Students learn how to document an architecture Students know how to Defend and criticize the choices made when designing an architecture Students learn how to justify the choice of an architecture for the realization of software, taking into account its functional and non-functional requirements Students learn how to present the model of an architecture using UML diagrams Competences: C3, C5, C8, C9, C13
Content	Preamble – History – Software Quality Criteria in games – Reminder (UML diagrams for software architectures) Chapter 1. Introduction to Software Architectures 1. Positioning of the software architecture 2. Key concepts & typology 3. Principles of software architectures 4. Paradigms of software architectures 5. Usefulness of software architectures 6. The profession of software architect Chapter 2. Architectural Styles 1. Definitions of an architectural style 2. Architectural Style Vs Design Pattern 3. Typology of architectural styles Chapter 3. Aspect-Oriented Programming 1. Problem and solution 2. Principles 3. Aspects 4. Weaving 5. Lab 1 with the AJGT plug-in

	Chapter 4. Data-centric 2-tier approach Part 1. 2-tier architectures – (Client/Server, Peer-to-Peer) – Practical work 2: Database + JDBC (java client + DBMS + biblio.jar) Part 2. Multi-layer architectures – TP3: logical distribution in 2 layers (Graphic+Logic) – TP4: MVC Chapter 5. Managing persistence 1. Persistence 2. ORM 3. Architecture with persistence 4. The Hibernate Framework 5. TP5: Class-Table Mapping (the JBoss server) 6. TP6: Mapping Association-link (one-to-many) 7. TP7: Heritage Chapter 6. Documentation of software architectures 1. Architecture Description Languages (ADL) 2. Types of LDAs 3. Examples of ADLs 3.1. Wright 3.2. Darwin Chapter 7. Component-Based Architecture 1. The component 2. Component-based architecture 3. Java Beans: TP7 Chapter 8. Micro-services architecture and containerization 1. Monolithic architecture vs micro-services architecture 2. Containerization 3. The DEVOPS approach 4. TP8: Jenkins + Docker
Examination forms	50% continuous assessment + 50% written exam
Study and examination requirements	10/20
Reading list	- Printz, J. (2012). Architecture logicielle: Concevoir des applications simples, sûres et adaptables (3rd ed.). Dunod. - Bailet, T. (2012). Architecture logicielle: Pour une approche organisationnelle, fonctionnelle et technique. ENI. - Bass, L., Clements, P., & Kazman, R. (2012). Software Architecture in Practice (3rd ed.). Addison-Wesley. - Gabay, J., & Gabay, D. (2008). UML 2 Analyse et Conception: Mise en œuvre guidée avec études de cas. Dunod.

SEC.4.1 Cybersecurity & Cryptography

Module designation	SEC.4.1 Cybersecurity & Cryptography
Semester(s) in which the module is taught	S4
Person responsible for the module (coordinator)	Mohamed Houcine Elhdhili
Teachers	Naouel Ben Salem Grati, Maroua Bakri, Rihab Boussaada
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson, exercices, labs
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (20h lesson, 10h exercises, 15h labs) Private study: 30h

Credit points	3ECTS
Required and recommended prerequisites for joining the module	Net.3.1&2 Local Area Networks, AP.2.2 web technologies OS.2.1 Introduction to operating systems and Unix environment
Module objectives/intended learning outcomes	Knowledge: After completion of this course, students will ● Be able to make a basic risk assessment of a simple system under well-defined conditions and scenarios. ● Be able to classify different types of cyber attacks and propose basic countermeasures. ● Know basic cryptographic protocols and some of their use cases ● Know how to use simple cryptanalysis tools ● Know how to use a simple vulnerability scanner Competencies: C1, C3, C4, C6.
Content	Part I : Introduction and risk assessment and evaluation Lesson 1 (6H) ● Definitions and terminology ● Risk assessment (group activity using a case study) Lesson 2 (3H) ● Classification of attacks (brainstorming using collaborative mind mapping) Lab 1 (6H) ● Basic usage of a network sniffer (passive attacks) ● Test of several network attacks using GNS3 ● Test of several system attacks using Webgoat Part II : Cryptography and cryptanalysis Lesson 3 (6H) ● Symmetric and asymmetric cryptography ● Key management Lesson 4 (3H) ● Cryptanalysis : Introduction and classification ● Example 1 : Substitution cipher ● Example 2 : RSA Lab 2 (6H) ● Cryptography under openssl ● Study of TLS and security of an application layer protocol Part III : Authentication and access control Lesson 5 (4.5H) ● Authentication techniques : classification and analysis ● DAC, MAC (Bell Lapadula) and RBAC ● Protocols : Kerberos, RADIUS and TACACS+ Lab 3 (3H) ● Kerberos authentication ● OpenOTP authentication Part IV : Network security Lesson 6 (4.5H) ● Firewalls, DMZ, IDS, IPS ● Network scanning ● Vulnerability scanners Lab 4 (3H) ● Vulnerability scanning :nessus, acunetix, W3af, nmap… ● Introduction to exploits with metasploit
Examination forms	50% Continuous assessment + 50% Written exam
Study and examination requirements	10/20
Reading list	- Menezes, A., van Oorschot, P., & Vanstone, S. (2001). Handbook of Applied Cryptography (5th ed.). CRC Press.

	- Stamp, M., & Low, R. M. (2015). Applied Cryptanalysis: Breaking Ciphers in the Real World. Wiley. - Konheim, A. G. (2007). Computer Security and Cryptography. Wiley-Interscience. - Mark Stamp and Richard M. Low, Applied cryptanalysis : breaking ciphers in the real world, Wiley, 2015 - Alan G. Konheim, Computer Security and Cryptography, Wiley-Interscience, 2007

FIN.4.1 Introduction to financial markets

Module designation	FIN.4.1 Introduction to financial markets
Semester(s) in which the module is taught	S4
Person responsible for the module (coordinator)	Snoussi Imen
Teaching team	Mouna Ben Salah, Amor Oueslati
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours : 45h (30h lessons, 15h exercises) Private study: 30h.
Credit points	3ECTS
Required and recommended prerequisites for joining the module	The course requires knowledge of basic financial mathematics,statistics, econometrics.
Module objectives/intended learning outcomes	This course introduces capital markets in general and financial markets in particular. Its main objective is to enable students to master the fundamentals of portfolio management. In addition, students will gradually become familiar with the terminology of the financial world. The course allows them to acquire an in-depth knowledge of financial assets ranging from classic products (stocks and bonds) to the most sophisticated (options, futures, complex option strategies, etc.). Particular emphasis is placed on the valuation of the various products presented. Competences: C11, C12, C13.
Content	

	Chapter 0 - General Information on Capital Markets 1) Money market and financial market 2) Financial market securities (stocks and bonds) 3) Derivative markets Chapter 1-Fundamental Principles of Portfolio Diversification 1) Profitability 2) Risk 3) Diversification and the portfolio concept (profitability, risk, covariance) 4) Effect of diversification on risk reduction (perfect correlation and imperfect correlation) 5) The minimum variance portfolio. Chapter 2- The Capital Asset Pricing Model: CAPM 1) Assumptions 2) Mathematical derivation 3) The relationship between SML and CML 4) Return on risk 5) Equilibrium price (undervaluation and overvaluation) Chapter 3-Elements of bond management 1) Characteristics of conventional bonds (face value, face rate, maturity, issue premium, redemption premium, coupon, accrued coupon, amortization, etc.) 2) Actuarial yield of a bond (calculation on coupon dates and intermediate dates) 3) Coupon Pricing (CPC) 4) Duration 5) Sensitivity (synthesis of the two effects coupon and maturity) 6) Convexity Chapter 4 - Derivative Markets 1) Futures and Forwards 2) Basic option strategies (calls and puts) 3) Determinants of option prices 4) Intrinsic value and time value of an option 5) Some complex option strategies (Straddle, Strangle, Butterfly...) 6) Convertible bonds (operation and valuation by the binomial model)
Examination forms	35% continuous eval+65% written exam
Study and examination requirements	10/20
Reading list	- Fontaine, J., & Hamet, J. (2011). Les marchés financiers internationaux. PUF. - Gresse, C. (2017). Marchés de taux d'intérêt. Economica. - Hull, J. (2014). Options futures et autres produits dérivés. Pearson. - Jacquillat, B., Solnik, P., & Pérignon, C. (2014). Marchés financiers. Dunod. - Le Saout, E. (2016). Introduction aux marchés financiers. Economica.

DDP.4.1 Design and development project

Module designation	DDP.4.1 Design & Development project
Semester(s) in which the module is taught	S4
Person responsible for the module (coordinator)	Head of department Intelligent Decision Systems
Language	French/English
Relation to curriculum	Compulsory
Teaching methods	Project
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours with the supervisor: 20h Self-work:55h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	Depending on the theme of the project, can cover all school modules.
Module objectives/intended learning outcomes	Students learn to work in a group (pair or trinomial) on a project resulting from a challenging problem, which includes: study of the bibliography, a phase of modelling the problem (analysis), design of the solution, teamwork with interaction with the supervising teacher. Students know how to use management project tools (such as Trello) and Git to develop in parallel their project Competences: C1, C2, C3, C4, C5, C6, C7, C9, C10, C11, C12, C13.
Content	● Redaction of problem specifications ● Problem analysis ● Design ● Achievement ● Tests and experimentation ● Writing a report ● Project and team management ● Defense in front of an academic jury
Examination forms	50% Supervisor evaluation + 50 % jury evaluation
Study and examination requirements	10/20
Reading list	

BDC.4.1 Introduction to Entrepreneurship and innovation

Module designation	BDC.4.1 Introduction to Entrepreneurship and innovation
Semester(s) in which the module is taught	S4
Person responsible for the module	BEN SAÏD Wissem
Team	GUERMEZI Houda, MOKRANI Fatma
Language	French
Relation to curriculum	Compulsory
Teaching methods	Lesson, supervised work
Workload (incl. contact hours, self-study hours)	Total workload: 75 h Contact hours: 45 h (30h lessons, 15h case studies) Private study: 30 h
Credit points	3ECTS
Required and recommended prerequisites for joining the module	Finance, marketing and HRM function, statistics, probability, graph theory
Module objectives/intended learning outcomes	Module objectives : - Master the legal and ethical context of inter and/or intra-company charters for the proper use of ICT at work. - Apply legislation on the protection of digital works, databases, software licenses and know the risks incurred in the event of non-compliance. - Estimate accidental and intentional risks so that the necessary measures can be taken. - Be part of a logic of monitoring and protection of company information with reference to concepts of economic intelligence - Make information usable in a business context: manage, organize, distribute and store it. - Master supply management. - Master the different inventory management - Master the different stages of business creation - Acquire ideation skills. - Master prototyping techniques - Master the strategic analysis of a new project - Develop the business plan - Master the legal procedure for setting up a business Competences: C9, C10, C12, C13

Content	At the end of the module, the student will have knowledge of the internal functioning of the company and the different stages of creation, which allows him both to build his own project and to manage it.
	
	• Ch 1. The supply function
	  • Supply procedure
	  • Supply organization
	  • Supply management
	  • Inventory management
	• Ch 2. The production function
	  • Purpose of the function
	  • Production policies
	  • Production process
	  • Production organization

	• Production optimization • Ch 3. Business creation • Ideation • The personal project • The strategic study of the project • Financial forecasts • Development of the business plan • The statutes, the legal procedure and formalities
Examination forms	35% Continuous evaluation and 65% written exam
Study and examination requirements	10/20
Reading list	- Riel, D. (2021). Entrepreneur 2.0: Méthode d'entreprenariat [Amazon Digital Services LLC]. - Paun, F. (2014). Tous entre-preneurs !: La croissance du XXIe siècle à l'heure entrepreneuriale. Editions L'Harmattan. - Bussenault, C., & Pretet, M. (1995). Economie et Gestion de l'Entreprise. Vuibert. - Capul, J. Y., & Garnier, O. (1996). Dictionnaire de l'Economie et des Sciences Sociales. Hatier. - Haran, G. (1995). Méthode PERT: Gestion et ordonnancement de projets par la méthode du chemin critique. Eyrolles. - Fournier, J. C. (2011). Théorie des graphes et applications: Avec exercices et problèmes. Lavoisier. - Lochard, J. (1998). La comptabilité analytique ou comptabilité de responsabilité. D'Organisation. - Assoumou Menye, O. (2017). Comptabilité analytique d'exploitation: Cours, exercices et cas corrigés. Editions L'Harmattan. - Portella, A. (2009). 100 fiches pour créer son entreprise. Studyrama Eds. - Zouaoui, M., & Zouaoui-Karoui, S. (1999). Le management: Processus de gestion et fonctions de l'entreprise. La CLE. - Bergerault, F., & Bergerault, N. (2013). De l'idée à la création d'entreprise: Comment concrétiser votre projet. Dunod. - Papin, R. (2017). Création d'entreprise: De l'idée au business plan. Dunod. - Saulais, P. (2022). Connaissance et idéation: Analyser les connaissances inventives pour stimuler l'idéation. ISTE Group. - Hallgrimsson, B. (2020). Prototypage et design produit: Des procédés aux matériaux. Dunod.

BDC.4.2 Language and communication 4: Communication Techniques

Module designation	BDC.4.2 LANGUAGE AND COMMUNICATION 4: Communication techniques
Semester(s) in which the module is taught	S3 or S4
Person responsible for the module (coordinator)	Sabry NEJI
Language	French
Relation to curriculum	Compulsory
Teaching methods	lecture, lesson, presentations.
Workload (incl. contact hours, self-study hours)	Total workload: 75h Contact hours: 45h (12h lessons, 33h presentations) Private study including examination preparation: 30h
Credit points	3 ECTS
Required and recommended prerequisites for joining the module	● French language rules used in communication (logical articulators, deictics, modal verbs and adverbs…) ● Exchanging ideas in a consistent way. ● Speaking fluently. ● Writing various administrative documents (CV, letters of motivation, activity reports…)
Module objectives/intended learning outcomes	● students learn to adapt their communication according to the audience (specialists or neophytes) or the context in which the function is performed (National or international) by mastering at least 3 languages. ● Develop leadership and entrepreneurial skills and the ability to innovate, particularly through socio-cultural projects. ● Become aware of the need to constantly update your knowledge and, if necessary, to undertake additional studies. Extended learning objectives : ● Being able to exchange thoughts and opinions harmoniously. ● Building a solid argumentation using the suitable communication techniques. ● Listening and discussing other people's opinions. ● Developing critical thinking. ● Acquiring the necessary tools for discussions and debates. ● Knowing how to speak in public, presenting and convincing the audience. Competences: C11
Content	Chapter I - Course presentation and distribution of works - Applying first year's requirements in Writing various administrative documents (CV, letters of motivation, activity reports…) - Watching and commenting video footages - Oral presentation After the first two sessions of introduction to the communication course, as a fundamental concept for the future engineer's professional and personal life, the rest of the sessions will be essentially conducted in a participatory way. First, students will watch video footages and will deduce the oratory techniques that lead them to captivate their audience and defend their theses.

	Then, all the students will give an oral presentation, whether they choose to be alone, or in small groups. Various topics will be treated, dealing with the information society or any subject of their choosing they want to discuss. After that, the audience will debate about the given presentation and will criticize some points using the critical analysis techniques acquired. Chapter II - Roleplays - Speaking in public Students will conduct roleplays representing life in the company or enterprise they might be part of. The audience will discuss them. Within these roleplays, students will be able to speak in public, in order to present a project they consider as particularly important. The audience will debate about the techniques used to convince them (or not). Approach used: the approach used will be inductive. This approach is preferred because it gives to the students the opportunity to conceive their own knowledge, using different tools at their disposal, and with the supervision of their professor.
Examination forms	50% continuous evaluation (oral presentation, mini project and essay writing.); 50% written exam
Study and examination requirements	10/20
Reading list	Bourdieu, Pierre, Le Sens pratique, Les Editions de Minuit, 1980 Chamberlain, Alan et Steele, Ross, Guide pratique de la communication, éd. Didier, Paris, 1991 Charles, René et Williame, Christine, La Communication orale, éd. Nathan, 2020

Level 2 Internship

INT.4.1 Immersion internship

Module designation	INT.4.1 immersion internship
Semester(s) in which the module is taught	between semesters 4 and 5 (summer period)
Person responsible for the module (coordinator)	Internship director
Language	French/English
Relation to curriculum	Compulsory
Teaching methods	Project – autonomous work During the internship, the intern's work is overseen by the supervisor at the hosting entity.
Workload (incl. contact hours, self-study hours)	Total workload: between 6 and 8 weeks in the hosting entity.
Credit points	6 ECTS
Required and recommended prerequisites for joining the module	Depending on the theme of the project, can cover from S1 to S4 ENSI modules. Only ENSI students who have successfully completed their second year of computer science engineering studies can join.
Module objectives/intended learning outcomes	The main objective of this immersion internship is to enable ENSI students develop professional experiences through real practices enhancing and sharpening their scientific, technological, personal skills in the hosting company. This will put the intern in touch with the realities of the industry and give her/him the opportunity to implement, in a real setting, the theoretical knowledge acquired during the first two years of studies at ENSI. Students learn to work autonomously on a project resulting from a challenging problem, which includes: study of the bibliography, a phase of modeling the problem (analysis), design and implementation of a solution, teamwork with interaction with the enterprise teams and supervisor. Students improve their management skills through a professional use of management project tools to develop in parallel their solutions. Competencies: C1, C2, C3, C4, C5, C6, C7, C8, C11, C13

Content	– Solve a real problem in a production environment: contribute to the design and the implementation of a concrete solution through the achievement of the following main activities: ▪ Critical analysis & Problem formulation (context, requirements, constraints, …) ▪ Specifications and design of adequate solutions (processes modeling, system architecture, algorithms, …) ▪ Coding and testing ▪ Deployment and validation – Sharpen communication, collaboration and argumentation skills through at least: ▪ Regular work in progress presentations to the team/supervisor at the hosting company, ▪ Writing a synthetic report ▪ Defense in front of an academic jury
Examination forms	A first validation is performed by the supervisor of the hosting entity who will deliver an internship letter validation or appreciation. The final validation of the immersion internship takes place at ENSI, at the beginning of semester S5. The intern will have to defend her/his work during an oral presentation in front of a jury made up of at least two ENSI teachers. A representative of the hosting entity may attend the internship validation jury as a guest member. Such validation consists in assessing the performed work through the written synthesis report, the developed solution and the oral presentation.
Study and examination requirements	Validated internship
Reading list	McMillan, K., & Weyers, J. (2021). "How to write Dissertations and Project Reports". Bowden, J. (2008). "Writing a Report: How to prepare, write and present really effective reports", 8th Edition, How To Books.

Semester 5: Common Modules

code	Title	type	Coefficients	ECTS	Total workload	Contact hours	Private study
BDC.5.1	Complex Project Management	Compulsory	1	1	25	15	10
BDC.5.2	Computer Law and Human Rights	Compulsory	1	1	25	15	10
BDC.5.3	Language and communication5: Preparing for Standardized exams	Compulsory	1	1	25	15	10

BDC.5.1 Complex Project Management

Module designation	BDC.5.1 Complex Project Management
Semester(s) in which the module is taught	1st Semester
Person responsible for the module	Houda HAKIM GUERMAZI.
Team	Fatma MOKRANI
Language	French
Relation to curriculum	Compulsory
Teaching methods	lecture, lesson , project .
Workload (incl. contact hours, self-study hours)	Total workload:25 h Contact hours: 15h Private study including examination preparation: 10h
Credit points	1
Required and recommended prerequisites for joining the module	management of organization (ref BDC1.1) Business creation course Applied probabilities course (ref MAT 1.1) software engineering course Operational research course
Module objectives/intended learning outcomes	Familiarize students with the concepts of project management - Help students to : • Identify the stakeholders of a project. • Identify the steps of a project. • To master the WBS of a project • To master planning process, • To master quality management and risk management project. • To master the capitalization of a project
Core competences	• Competence in resource management: Human, financial, intercultural values, time, etc. • Competence in risk management • competence in quality management • Negotiation skills • Coaching skill • communication skills • Project management competence: from planning to execution
Content	• Concept Content .Stakeholders of a project • Organizational structures and project life cycle • The phases of a project from ideas to execution
Examination forms	100% Final written exam.
Study and examination requirements	10/20
Reading list	Stéphane Badreau (2021) Gestion de projet agile De la définition du besoin à la livraison d'un produit de qualité, edition ENI Jérôme Maes, François Debois (2021) La boîte à outils du chef de projet , Dunod (3eme edition) 208 pPMbooks A Guide to the Project Management Body of Knowledge (2013) (PMBOK® Guide) – Fifth Edition (2013) Project Management Institute, Inc. All rights reserved.

	Vincent Drecq Pratiques de management de projet 50 outils et techniques pour réussir vos projets, (2020) 3eme edition Dunod Gregory Horine (2017) Project Management Absolute Beginner's Guide, 4th edition Hugues Marchat (2009) La gestion de projet par étapes Véronique messager rota, Gestion de projet Vers les méthodes agiles, Eyrolles Terry Schmidt,(2009) Strategic Project Management Made Simple: Practical Tools for Leaders and Teams Yvon MOUGIN (2004) Processus :les outils d'optimisation de la performance, Éditions d'Organisation, .

BDC.5.2 Computer Law and Human Rights

Module designation	BDC.5.2 : Computer Law and Human Rights
Semester(s) in which the module is taught	S5
Person responsible for the module (coordinator)	Ines Louati
Language	French
Relation to curriculum	Compulsory
Teaching methods	lesson
Workload (incl. contact hours, self-study hours)	Total workload: 25h Contact hours : 15h (10h Lectures, 5H exercises) Private study: 10h
Credit points	1ECTS
Required and recommended prerequisites for joining the module	The course is accessible to students without legal training and the assessment system takes this into account.
Module objectives/intended learning outcomes	This course should enable students to: - Master the fundamental elements of computer law resulting from the needs of practice. - Become familiar with the legal environment of IT. - To be able to protect themselves as creators of software. - To know the basics of the concept of personal data, to identify the rights that flow from it and to be aware of the issues. Competences: C6, C8, C13.
Content	Lesson 1 (2H) : Introduction ● The information society and the digital revolution ● Regulation of the information society. ● Definition of IT law. Lesson 2 (3H) : Protection of Industrial property ● Protection of software by the patent of invention ● Protection of software by industrial design law ● Protection of software by trademark law. Lesson 3 (7H) : Protection of software by copyright ● Conditions of protection ● Scope and legal duration of protection ● Effects of protection: moral and economic rights ● Legal consequences of the protection ● Action for infringement

	Lesson 4 (3H) : Protection of personal data ● Definition and typology ● Human Rights ● Obligations of the person responsible.
Examination forms	100% Written exam
Study and examination requirements	10/20
Reading list	- Joly, P. (1978). Law and IT. Eyrolles. - Castets-Renard, C. (2009). Internet Law. Montchrestien-Lextenso ed. - GDPR texts amended Data Protection Act of 1978: new - data protection. Dalloz. (2018). - Legal news: Intellectual Property Law and NTIC. (n.d.). Retrieved from http://www.juritravail.com/actualite/propriete-intellectuelle-ntic

BDC.5.3 Language and communication 5: Preparing for standardized exams

Module designation	BDC.5.3 Language and communication5: Preparing for Standardized exams
Semester(s) in which the module is taught	S5
Person responsible for the module (coordinator)	Faycel DHAKHLAOUI
Teaching team	Hanen JAYARI
Language	English
Relation to curriculum	Compulsory
Teaching methods	Lecture, project, group work,
Workload (incl. contact hours, self-study hours)	Total workload:25h Contact hours :15h (5h lessons, 10h practice) Private study including examination preparation:10h
Credit points	1ECTS
Required and recommended prerequisites for joining the module	General English intermediate level
Module objectives/intended learning outcomes	- To introduce students to the challenges involved in sitting for standardized exams. - To familiarize students with types of questions and to train them to the various difficulties involved in sitting for a standardized exam which the TOEIC. Competences: C11
Content	Lesson 1: Introduction of standardized exams: TOEIC, TOEFL and IELTS 5- TOEFL 6- TOEIC 7- IELTS Lesson 2 : All about the TOEIC 5- Reasons for sitting for the exam 6- The certificates and the scores 7- Physical and mental preparation Lesson 3 : Business related issues 5- TOEIC and business 6- From which context are the questions of the TOEIC drawn.

	7- Challenges and keys to a successful performance Lesson 4 : Answering Listening comprehension questions 4- The challenges of listening 5- Commenting on pictures about business 6- Sample questions: Assessment and correction. Lesson 5 : Answering reading comprehension 5- The importance of reading. 6- Reading for grammar 7- Diagnosing mistakes 8- Making intelligent choices 9- Sample questions: reading comprehension and error recognition
Examination forms	100% Written exam
Study and examination requirements	10/20
Reading list	- 600 essential words for the TOEIC

Annex 1: IT Framework Competencies

C1. To master in depth the basic sciences, in particular computer science and mathematics, essential for the design and production of computer applications.

C2. Set up a technology watch system to select the relevant tools and methodologies in the design, production or maintenance of an Information System (IS).

C3. Analyze complex IS architectures considering non-technical constraints such as societal, health and safety, environmental or economic constraints.

C4. Identify, formulate and solve complex or incompletely defined IT problems with the objective of ensuring maximum availability for users.

C5. Specify an information system in all its dimensions: software, hardware and architecture using the state-of- the-art available technologies and taking into account the company's strategic objectives

C6. Assess the vulnerability of an IS and implement solutions to protect applications and data.

C7. Identify, locate and collect all the data necessary for the research and development of new software or new IS architectures.

C8. Master good practices in terms of software development as well as applicable standards and regulations.

C9. Make complex decisions based on incomplete or limited information.

C10. Lead an IT project by mastering people management, risk analysis, budget compliance and change management (IS implementation).

C11. Adapt your communication according to the audience (specialists or neophytes) or the context in which the function is performed (National or international) by mastering at least 3 languages.

C12. Develop leadership and entrepreneurial skills and the ability to innovate, particularly through socio-cultural projects.

C13. Become aware of the need to constantly update your knowledge and, if necessary, to undertake additional studies.