Programme détaillé de la 2ème année du cycle préparatoire

Semestre 3

Module : Data Structures and Algorithms 2

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Fondamentales 3.1	67.5	4.5	1.5	1.5	1.5	4	5

Course Description:
This module introduces the principal fundamentals of data structures and algorithms used in computer science. Data structures will be formulated to represent information in such a way that it can be conveniently and efficiently manipulated by the algorithms that are developed.
On successful completion of this module, students should be able to demonstrate understanding of abstract models of data and computation, to explain and apply data structures such as binary trees, heap-trees, graphs and tables, and to explain the differences between basic complexity classes of algorithms (constant, linear, quadratic, logarithmic, exponential).

Prerequisite : Introduction to Programming, Object-Oriented Programming

Evaluation Method : Coursework (40 %) + Final Exam (60%)

Course Content

- Introduction
- Efficiency and Complexity
- Sorting Algorithms
- Basic data structures and operations
  - Linked Lists
  - Queues
  - Stacks
- Trees
  - Binary Trees
  - AVL Trees
  - Heap Trees
  - B-Tree
- Hash Tables
- Graphs

References

- Weiss, Mark A. Data Structures and Algorithm Analysis in C++ (4rd Edition), Pearson. 2014
- Michael T. Goodrich, Roberto Tamassia, David M. Mount, Data Structures and Algorithms in C++ 2nd Edition, Wiley, 2011

- John Bullinaria, Lecture Notes for Data Structures and Algorithms, School of Computer Science. University of Birmingham. Birmingham, UK. Version of 27 March 2019. https://www.cs.bham.ac.uk/~jxb/DSA/dsa.pdf
- Malik, D S. Data Structures using Java (2nd Edition), Cengage Learning. 2009

Module : Mathematical Analysis 2

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Fondamentales 3.1	67.5	4.5	1.5	3		3	5

Course Description:
This course is a continuation of Continuous Mathematics 1 and covers topics in multivariate calculus, numerical series, and Fourier series. The course begins with a study of multivariate numerical and vector functions, including partial derivatives, gradients, and optimization. This leads into a study of multiple integrals. The course then moves on to numerical series, and the study of sequences and series of functions. Finally, the course covers Fourier series, including convergence and periodic functions.

Prerequisite : Continuous Mathematics 1

Evaluation Method : Coursework (40 %) + Final Exam (60%)

Course Content

- Multivariate Numerical and Vector Functions
- Multiple Integrals
- Numerical Series
- Sequence and series of functions
- Integer Series
- Fourier Series

References

- Bruno Aebisher, Fonctions à plusieurs variables et géométrie analytique cours et exercices corrigés. edition Vuibert.
- Kada Allab, Eléments d'Analyse : fonction d'une variable réelle, O.P.U. 2002.
- Nourdine El jaouhari, Calcul différentiel et calcul intégrale. Edition Dunod.
- Mohamed Hazi, De mes cahiers d'analyse O.P.U.
- Jean-Marie Monier, Analyse MP : Cours, méthodes et exercices corrigés
- Walter Rudin, Principes d'Analyse mathématique.

Module : Mathematical Logic

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Fondamentales 3.1	45	3	1.5	1.5		2	4

Course Description

This course aims to provide the basic notions of formal logic, mainly the syntax and semantics of propositional logic and first-order predicate logic. At the end of the course, the student will be able to manipulate logical expressions, check their well-formedness and deduce new expressions. The student will also be able to analyse the truth or falsity of a statement using the notions of satisfiability and model theory as well as verifying the validity of reasoning through systems of formal proof.

Prerequisite : Algebra

Evaluation Method

Coursework (40%) + Final Exam (60%)

Course Content

- Informal natural deduction
- Propositional logic
- Quantifier-free logic
- First-order logic

References

- Ian Chiswell. Mathematical Logic. Oxford University Press. 2007
- Shawn Hedman. A first course in logic : an introduction to model theory, proof theory, computability, and complexity, Oxford: Oxford University Press, 2004

Module : Databases

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Methodologiques 3.1	67.5	4.5	1.5	1.5	1.5	3	5

Course Description :
The object of this course is to teach students the general concepts of relational databases and how to design a database that is anomaly free. Students will learn to design, create, populate, and query a database by working with a relational database engine and the SQL language. Students will also learn basic database administration skills such as creating users, granting/revoking privileges individually or collectively to several users through the use of roles. Further, students will learn how to create constraints with triggers in addition to the use of PL/SQL language.

Prerequisite : Programming, Data Structures

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Database Systems
- The Relational Database Model
- Entity Relationship (ER) Modelling
- Normalisation of Database Tables
- Introduction to Structured Query Language (SQL)
- Advanced SQL (LABS)
- Transaction Management and Concurrency Control

References

- Carlos Coronel and Steven Morris. Database Systems: Design, Implementation, & Management, 13th Edition, 2018.
- Raghu Ramakrishnan, Johannes Gehrke. Database Management Systems, McGraw-Hill Higher Education; 3rd edition. 2002
- Ramez Elmasri, Shamkant B. Navathe. Fundamentals of Database Systems, Pearson; 7th edition, 2015.

Module : Probability

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Methodologiques 3.1	45	3	1.5	1.5		2	4

Course Description :
This course covers the classical aspects of probability theory and focuses on the probabilistic model and its basic properties. It also considers random experiments whose characteristic of interest can be modelled by univariate or multivariate random variables (discrete or continuous). It introduces random vectors, sequences of random variables, and different aspects of convergence. Finally, students will be introduced to elements of statistical and Bayesian inference, such as parameter estimation and hypothesis testing.

Prerequisite : Probability and Statistics I, Analysis

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Discrete Random Variables
- Continuous Random Variables
- Jointly Distributed Random Variables
- Properties Of Expectation
- Generating Functions

References

- Sheldon M. Ross, A first course in probability, Pearson, 2018.
- Hossein Pishro-Nik, Introduction to probability, statistics and random processes, Kappa Research, 2014.
- Sheldon M. Ross, Introduction in probability and statistics for scientists and engineers, Academic Press, 2014.
- David Forsyth, Probability and statistics for computer science, Springer, 2018
- Mario Triola, Elementary Statistics, Pearson, 2021.
- F.M. Dekking, C. Kraaikamp, H.P. Lopuhaa and L.E. Meester: A Modern Introduction to Probability and Statistics: Understanding Why and How, Springer, 2005.

Module : Web Development

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Methodologiques 3.1	67.5	4.5	1.5		3	2	6

Course Description:

This course is an introduction to programming for the World Wide Web. Students will be taught the concepts for developing web applications using various technologies and frameworks including JavaScript and server-side programming languages. The course will cover in depth the following aspects:

- JavaScript for creating interactive web pages
- Asynchronous JavaScript and XML (Ajax) with fetch and JSON for enhanced web interaction and applications
- PHP Hypertext Processor for generating dynamic pages on a web server
- Web services for handling and responding to client-side requests
- Security for Web Applications

Prerequisite : Information Technology Essentials, Introduction to Programming, Databases

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Server-Side Programming
  - Server-Side Basics
  - Programming Languages
  - Web Frameworks
- Javascript : Client-Side Programming
  - Introduction to JavaScript
  - JSON Data format
  - JavaScript Frameworks
- Integration & Extension
  - Database Programming
  - Web Services and APIs
  - Using Cloud Technologies
  - Large Scale Web Applications
- Web Security

References

- W3 Schools. Online content. https://www.w3schools.com (HTML, CSS, JS)
- David Flanagan. The Definitive Guide: Master the World's Most-Used Programming Language, *7th Edition*, 2020
- Robin Nixon. Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5 (Learning PHP, MYSQL, Javascript, CSS & HTML5, 2018

Module : Introduction to Business

Semestre 3, CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Transversales 3.1	22.5	1.5	1.5	0	0	1	1

Course Description :

This course provides a comprehensive, integrated, and step-by-step approach to creating innovative and highly successful products. It focuses on the iterative process that motivates students toward the foundation of a business. This course breaks down the necessary process into various steps detailed in the course content.

Prerequisite :

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Developing Managerial Competencies;
- Learning from the History of Mgt, Thought
- Ethics and Social Responsibility
- Assessing the Environment
- Managing Globally
- Fostering Entrepreneurship and startups
- Formulating Plans and Strategies
- Fundamentals of Decision Making
- Using Planning and Decision Aids
- Achieving Organisational Control
- Motivating Employees
- Dynamics of Leadership
- Communicating Effectively
- Working in Teams
- Understanding Org. Culture & Cultural Diversity
- Designing Organisations
- Guiding Org Change and Innovation
- Managing Human resources
- Understanding marketing concepts and strategies
- Understanding financial statements.

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References

- Bill Aulet. Disciplined Entrepreneurship: 24 Steps to a Successful Startup. Wiley. 2013.
- John W. Slocum, Don Hellriegel, Susan E. Jackson, Competency-based Management, 2008, Thomson South-Western

Semestre 4

Module : Computer Architecture

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Fondamentales 4.1	67.5	4.5	1.5	1.5	1.5	3	5

Course Description :
This course provides an introduction to computer organisation, systems programming and the hardware/software interface. Topics include instruction sets, computer arithmetic, datapath design, data formats, addressing modes, memory hierarchies including caches and virtual memory, I/O devices, bus-based I/O systems, and multicore architectures. Students learn assembly language programming and design a pipelined RISC processor.

Prerequisite: Computer Architecture I, Data Structures and Algorithms

Evaluation Method: Coursework (40%) + Final Exam (60%)

Course Content

- Introduction of RISC-V Architecture
- RISC-V Instruction Set
- RISC-V Programming Model
- RISC-V: Processor Design
- Pipelining
- Cache Management
- Virtual Memory
- I/O & interrupts
- Advanced Computer Architecture (Optional)

References

- John L. Hennessy, David A. Patterson, Computer Organization and Design. The Hardware/Software. Interface: RISC-V Edition. 2nd Edition. 2020.

Module : Theory of Computing

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Fondamentales 4.1	45	3	1.5	1.5		3	4

Course Description :
The aim of this module is to provide the basic concepts for the theory of computational complexity. The main models of computability are explained providing various examples of undecidable problems. Further, students are taught the measures of the complexity of problems and of algorithms, based on time and space being used on abstract models. Complexity classes are explained along with the notion of completeness established through a thorough study of NP-completeness.

Prerequisite : Introduction to Programming, Data Structures and Algorithms

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Introduction to Computational theory
- Deterministic Finite Automata
- Non-Deterministic Finite Automata
- Regular Expressions
- Regular and Non-Regular Languages
- Context Free Grammar
- Pushdown Automaton
- Context Free Languages
- Turing Machines
- Variations and Turing Machine
- Decidability and Reducibility
- Complexity Theory
- Advanced Topics

References

- Michael Sipser. Introduction to the Theory of Computation. 3rd Edition. 2012
- Sanjeev Arora, Boaz Barak. Computational Complexity: A Modern Approach. 2009.
- Ingo Wegener and R.Pruim. Complexity Theory: Exploring the Limits of Efficient Algorithms. 2005.
- Steven Homer and Alan L. Selman, Computability and Complexity Theory, Springer Verlag New York, 2011

Module : Operating Systems

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Fondamentales 4.1	67.5	4.5	1.5	1.5	1.5	3	5

Course Description:
The purpose of this course is to provide an overview of computer operating systems. Topics to be discussed include a brief history of OS's and their design and development. The course will start with a presentation of a Linux OS and how to manipulate a Linux-like workstation for development purposes. Then, the course will cover major OS components and the underlying algorithms and implementation techniques. Programming assignments will be done on Linux machines.

Prerequisite : Operating System 1, Computer Architecture 1

Evaluation Method : Coursework (40 %) + Final Exam (60%)

Course Content

- Overview of Operating Systems
- Background and Basics
- Processes
- CPU Scheduling
- Process Synchronisation
- Deadlocks
- Memory Management
- Storage Management
- File System Implementation
- Virtualization & Containers

References

- Silberschatz, A., Galvin, P.B., and Gagne, G. (2018) Operating System Concepts (10th Edition), John Wiley & Sons, Inc.
- Tanenbaum, A. and Bos, H. Modern Operating Systems (4th edition), Prentice Hall. 2014.

Module : Statistical Inference

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Methodologiques 4.1	45	3	1.5	1.5		3	4

Course Description :
This course covers the classical aspects of probability theory and focuses on the probabilistic model and its basic properties. It also considers random experiments whose characteristic of interest can be modelled by univariate or multivariate random variables (discrete or continuous). It introduces random vectors, sequences of random variables, and different aspects of convergence. Finally, students will be introduced to elements of statistical and Bayesian inference, such as parameter estimation and hypothesis testing.

Prerequisite : Probability and Statistics I, Analysis

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Limit Theorems
  - Chebyshev's Inequality and the Weak Law of Large Numbers
  - The Central Limit Theorem
  - The Strong Law of Large Numbers
- Statistical Inference
  - Point Estimation
  - Interval Estimation
  - Hypothesis Testing

- Bayesian Inference

  - The Prior and Posterior Distributions
  - Inferences Based on the Posterior
  - Bayesian Computations
  - Choosing Priors

References

- Sheldon M. Ross, A first course in probability, Pearson, 2018.
- Hossein Pishro-Nik, Introduction to probability, statistics and random processes, Kappa Research, 2014.
- Sheldon M. Ross, Introduction in probability and statistics for scientists and engineers, Academic Press, 2014.
- David Forsyth, Probability and statistics for computer science, Springer, 2018
- Mario Triola, Elementary Statistics, Pearson, 2021.

Module : Mathematical Analysis 3

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Methodologiques 4.1	45	3	1.5	1.5		2	4

Course Description :
This course covers topics in advanced calculus, including integrals depending on a parameter, integral transformations, special functions, and extremum of a function with one or more variables. The course builds on the foundations of calculus, including limits, derivatives, and integrals. The course begins with a study of integrals depending on a parameter, including differentiation under the integral sign and the Laplace transform. This leads into a study of integral transformations, including the Fourier transform. The course then covers special functions, including the gamma function, the beta function, and the Bessel functions. The course concludes with a study of the extremum of a function with one or more variables, including Lagrange multipliers and optimization in several variables.

Prerequisite : Continuous Mathematics 1 ans 2

Evaluation Mode: Coursework (40%) + Final Exam (60%)

Course Content

- Integral Depending on one Parameter
- Integral Transformations
- Special functions
- Extremum of a function with one or more variables

References

- Elie Azoulay & Jean Avignant, Mathématiques : cours et exercices. 3, Analyse, Auckland Paris etc. : Mc Graw Hill, 1984.
- Lokenath Debnath Dambaru Bhatta, Integral Transforms and Their Applications, Chapman and Hall/CRC; 2nd edition, 2006.
- Murray R.Spiegel, Fourier Analysis, Schaum's outline series, McGraw-Hill Education; 1st edition, 1974.

Module : Introduction to AI

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Methodologiques 4.1	90	6	3	1.5	1.5	4	6

Course Description :
This course is intended to expose the students to the general subject of Artificial Intelligence. In particular, it is meant to explain what it means for a computer to be “intelligent” and what aspects need to be modelled in terms of knowledge representation and reasoning mechanisms. Further, the module would teach students the various applications and research areas where artificial intelligence is used as the pivotal component for the aim to give students a glimpse of future research areas in this arena.

Prerequisite : Data Structures and Algorithms

Evaluation Method : Coursework (40%) + Final Exam (60%)

Course Content

- Introduction to AI
- Intelligent Agents
- Search
- Adversarial Search and Games
- Constraint Satisfaction Problems
- Knowledge Representation and Reasoning
- Automated Planning
- Key Application Areas for AI

References

- Russel, S. and Norvig, P. Artificial Intelligence, A Modern Approach (4th Edition), Pearson Education Limited. 2020. https://aima.cs.berkeley.edu/
- Luger, G. F., Artificial Intelligence - Structures and Strategies for Complex Problem Solving, Addison Wesley, 6th Edition, 2009.
- Poole, D., Mackworth, A, Artificial Intelligence - Foundations of Computational Agents, Cambridge University Press, Second Edition, 2017.

Module : Electronic Circuits Labs

Semestre 4 CP	VHS C/TD/TP	VHH Total C/TD/TP	V.H. Hebdomadaire			Coef	Crédits
			C	TD	TP		
UE Découvertes 4.1	22.5	1.5			1.5	1	2

Course Description:

This course aims to equip beginners with basic functional knowledge of the Arduino microcontroller through a practical approach. Students can expect to learn how to write and upload simple code, integrate various physical inputs and outputs, and build low-cost, low-power systems.

Prerequisite :

Evaluation Method : Coursework (40 %) + Final Exam (60%)

Course Content

- **Introduction, programming, and electronics**
  - A tour of the Arduino Uno and how to use the IDE to talk with it
  - Elementary programming; blinking an LED
  - Assembling the course kits and taking a tour of the components
  - Ohm's Law, DMMs, wiring using the board's built-in supply, and schematics
  - Reading buttons or potentiometers to change LED behaviours
- **Reading the world and responding to it**
  - Exploring different ways of getting data into and action out of the Arduino
  - Using an input of choice to drive an output of choice
  - Back of envelope sketches of a final project of choice
- **Project development, presentation, and critique**
  - Further development of project, testing, tinkering, exploring, etc.
  - Student project Presentation and peer critique

References

- Banzi, M., and Shiloh, M. (2015). Getting Started with Arduino: The Open Source Electronics Prototyping Platform (3rd Edition), Make Community, LLC.
- Monk, M. (2016). Programming Arduino: Getting Started with Sketches (2nd Edition), McGraw-Hill Education.
- Nicholas, S. (2020). Arduino Programming: A Comprehensive Beginner's Guide to learn the Realms of Arduino from A-Z, Independently published.