Bachelor in Software Engineering

Titles, contents and timetable

Escuela Técnica Superior de Ingeniería Informática

Universidad Rey Juan Carlos

Contents

Prologue

This document contains information about titles, contents and timetable of subjects taught in the Bachelor in Software Engineering, offered at Rey Juan Carlos University, Escuela Técnica Superior de Ingeniería Informática. This information pretends to be helpful to international students interested in visiting our University.

Contents in this document referred to subjects taught during course 2021-2022. More information can be consulted in

`https://www.urjc.es/estudios/grado/640-ingenieria-software`.

1

First Course

1.1 First Semester

1.1.1 Introduction to Programming

Pascal basic elements. Control structures. Subprograms. Recursion. Arrays. Records and files.

6 ECTS credits.

1.1.2 Logic

Introduction to Set Theory. Propositional logic (Syntax, Semantics and Gentzen Natural Deduction System). First order logic (Syntax, Semantics and Gentzen Natural Deduction System).

6 ECTS credits.

1.1.3 Statistics

Descriptive statistics: Description of data Basic concepts. Types of variables. Graphical summary of data. Numerical summary of data. Description of bivariate data. Summary of bivariate data. Covariance, correlation. Regression. Probability: random events, definition and interpretation of probability. Properties. Conditional probability. Independence of events. Total Probability and Bayes theorem. Random variables. Definition of random variable. Types of variables. Mass function and density function. Distribution function. Mean and variance. Special distributions. Statistical Inference: Introduction. Sampling. Central Limit Theorem. Estimation for means, proportions and variances. Hypothesis tests

6 ECTS credits.

1.1.4 Physical Basis of Computing

The fundamental laws of Electromagnetism Direct current circuits. Ohm's law. Kirchhoff's law. Thevenin equivalent circuits Semiconductors. PN junction. Diodes. LED diodes. Zener diodes. Circuits with diodes. BJT Transistors. Circuits with BJT transistors. MOSFET Transistors. Circuits with MOSFET transistors. Logic gates. Digital electronics. Sequential and combinational circuits. Mealy machine.

6 ECTS credits.

1.1.5 Discrete Math and Linear Algebra

Discrete Math: Fundaments. Modular arithmetic. Introduction to combinatorics. Graph Theory. Linear Algebra: Matrices and systems of linear equations. Vector spaces. Linear maps. Matrix diagonalization.

6 ECTS credits.

1.2 Second Semester

1.2.1 Calculus

The real line. Complex numbers. Functions: Overview. Limits and continuity. Derivatives. Derivative computation. Taylor polynomial. Study and graphical representation of functions. Primitive computation. Definite integrals. Fundamental Theorem of Calculus. Areas calculation. Sequences of numbers. Series of numbers.

6 ECTS credits.

1.2.2 Introduction to Computers

Introduction to computers. Binary system of numerical representation. Introduction to the languages of hardware description. Boolean algebra. Specification and synthesis of

combinational circuits. Combinational modules basic. Finite state machines. Memory elements. Basic sequential modules. Structure of a basic computer.

6 ECTS credits.

1.2.3 Informatics and Society

Principles of the Information Society. The development of Informatics. Epistemic foundations of the information societ. Information and communication technologies Transformations in the Information Society. Economic transformations Social and political transformations.

6 ECTS credits.

1.2.4 Data Structures

Introductory course to the classical data structures treated with the abstract data types (ADT) approach, and to the methodological development of programs using these structures. At the end of the course, students should know the properties, operation and possible implementations of the main data structures, and know when and how to use them for problem solving. Data structures, together with algorithms, are the pillars of computer programming, so it is a fundamental subject in any degree related to Computer Science. In fact, one of the main competences of these degrees is to correctly design and develop efficient computer programs. This course is taught in the second semester of the first year of the degree, as a continuation of the course Introduction to Programming of the previous semester. On the other hand, it serves as a basis for the rest of the programming subjects that are taught later in the degree.

Syllabus: Abstract Data Types (ADT) and software complexity. Linear data structures: list, stack and queue. Non linear data structures: set, tree and graph.

6 ECTS credits.

1.2.5 Basic Legal Principles, Professional Deontology and Equality

Ethics, engineering and human being.. Ethical and social responsibility. Basic legal principles. Introduction to Law. Basic legal principles of the Spanish legal system. Fundamental elements of Computer Law. Professional ethics and deontology of computers engineering. The importance of professional ethics. The profession of Software Engineer. Software licenses and business models.

6 ECTS credits.

1.3 Second Course

1.4 First Semester

1.4.1 Object Oriented Programming

Introduction to object-oriented programming. Introduction to the Java language. Inheritance and genericity in OOP. The java.lang package. Class Design. Genericity and Predefined Data Structures. Input Output in OOP. User Interfaces.

6 ECTS credits.

1.4.2 Web Fundamentals

This course is dedicated to fundamental principles and tecniques of the World Wide Web, starting with an historical perspective and previsible future evolution, studying the most important markup languages an related technologies in a practical manner, and introducing the basics of Web application architecture.

6 ECTS credits.

1.4.3 Databases

Database Foundations. Information Systems and Databases. File Systems versus Database Management Systems. Data Models Data model definition. Entity/Relationship model. Conceptual modelling. Relational model. Database Design. Database Logical Design. Normalization theory. Database Implementation. SQL: Definition, Manipulation and Control languages.

6 ECTS credits.

1.4.4 Computer Architecture and Engineering

Introduction to computer architecture and engineering. Architecture and organization. von Neumann model. Arithmetic login unit (ALU). Previous concepts. Basic arithmetic logic circuits. Bottom-up building of a simple ALU. Other arithmetic logic circuits. Data path and control unit. Synchronization methodology. Instruction set selection. Unicycle/multicycle data path: bottom-up building, functioning, control unit. Memory hierarchy. Main memory. Cache memory. Virtual memory. Peripherals and input/output management techniques. Peripheral model. Study of some peripherals. Management of input/output techniques: polling, interruptions, DMA. BUSES. Basic concepts. Types of buses. Synchronism. Bus arbiter. Examples of buses. Introduction to advanced computer architectures. Amdahl's law. Flynn's taxonomy. Introduction to advanced concepts: segmentation, dynamic instruction scheduling, dynamic branch prediction, multiple instruction issue, speculation, multiprocessors, clusters, non-uniform memory access, multicore processors, GPU.

6 ECTS credits.

1.5 Second Semester

1.5.1 Algorithm Design and Analysis

General algorithm concepts and recursion, time and space complexity analysis, graph algorithms, greedy algorithms, divide and conquer algorithms, dynamic programming, backtracking and branch and bound algorithms.

6 ECTS credits.

1.5.2 Programming Methodology

Specification and formal derivation. Basic concepts, introduction, problem specification, specification with predicates. Formal algorithm design techniques. Program Correctness: Formal verification of programs. Introduction to formal verification. Object-oriented design: Fundamentals of object-oriented design and development techniques. Design and OO analysis. Design patterns. Human-Machine Interaction. Team programming. Software Testing. Introduction to software testing. White box testing. Black box testing.

6 ECTS credits.

1.5.3 Operational and Statistical Management Methods

Introduction: The company and its purposes. Organization and structure of the company. The role of operations research in the companies. Mathematical Programming: Optimization models for management. Introduction to the solution methods. Postoptimization. Examples. Decision Theory: Introduction. Decision analysis. Multiobjective decision making. Examples. Project Management: Planning a project. Critical activities. Gantt chart. Cost balance and resource constraints. Other management methods. Quality management and design of experiments: X-R control charts. Design of experiments in quality control.

6 ECTS credits.

1.5.4 Requirements Engineering

Fundamentals: Introduction to software engineering. Definitions and concepts. Models of software processes. Software processes Levels of software engineering. Historical perspective and evolution. Introduction to requirements engineering. Software requirements. Characteristics of requirements. Types of requirements and classifications. Processes and standards. Unified Modeling Language. Requirements engineering: Extraction: Definitions. Techniques for the extraction of requirements. Stakeholders. Analysis: Definitions. Requirements modelling. Requirements analysis. Techniques for the analysis of requirements. Specification: Definitions. Techniques for the specification of requirements. Requirements documentation. Validation: Definitions. Techniques for the validation of requirements. Quality and change management.

6 ECTS credits.

1.5.5 Computer Networks

The Computer Networks course aims to provide basic training in the technical aspects of computer communication to undergraduate students of Computer Engineering, Software Engineering and Computer Engineering.

Computer networks concepts: protocols and technologies organized in a layered architecture. In this way, students will be able understand the different concepts and protocols and how all the parts fit together. Introduction to Internet. The Application Layer. Highlighting the technologies that support the Web, e-mail and P2P file sharing. The Transport Layer. It will be addressed explaining the reliable communication over an unreliable network layer, connection establishment and closure, and the agreement process, congestion and flow control, and multiplexing. The Network Layer. Fundamental topics such as route determination between two routers will be studied and the interconnection of a large number of heterogeneous networks. The

Data Link Layer and the Physical Layer. Fundamental problems such as the sharing of a multiple access channel, addressing, local area networks and the physical media used to transmit information.

At the end of the course, the student should be able to adequately design a computer network for a company, taking into account cost, performance and needs criteria.They should also be able to understand the technical description or documentation of a communications product, as well as the physical means used to transmit information.

6 ECTS credits.

2

Third Course

2.1 First Semester

2.1.1 Software Architecture Design

Introduction to sofwtware architecture, software-intensive systems and Industry 4.0, design patterns, architectural knowledge, evaluation of software architectures

6 ECTS credits.

2.1.2 Knowledge Engineering

Introduction to Artificial Intelligence, Problem solving through search (Uninformed search, Heuristic search, Advanced heuristic search, Multiagent search, Constraint satisfaction problems), Knowledge Representation (Description logic, Ontologies and Web services, Reasoning with imprecision), Machine Learning (Supervised learning/Decision Trees, Neural Networks, Reinforcement learning /Q-learning)

6 ECTS credits.

2.1.3 Operating Systems

This subject shows how operating systems work. Specifically, the student will understand the basic concepts of operating systems and will become familiar with their programming, understanding their principles and forms of application. The student will acquire knowledge related to the management of processes, memory and file system.

6 ECTS credits.

2.1.4 Operational Research

Introduction: History and development of the operational research. Methodology and model formulation. Applications. Deterministic models: Lineal optimization: Introduction, model formulation, graphic solution, resolution algorithms, optimization soft-

ware, solution analysis, duality, and economic interpretation. 3.- Integer optimization and combinatory: introduction, integer, and binary programming models, applications, strong and weak modelization, preprocessing, resolution algorithms. Stochastic models: Queue theory: Introduction, elements of the queue theory, stochastic processes, efficiency measures, Poisson models, queue networks. 5.- Simulation: Introduction, discrete events simulation systems, random number and random variable generation, Montecarlo simulation, applications.

6 ECTS credits.

2.1.5 Software Processes

Knowledge and application of the principles, methodologies and life cycles of software engineering. Ability to develop, maintain and evaluate software services and systems that meet all user requirements and behave reliably and efficiently, are affordable to develop and maintain and meet quality standards, applying the theories, principles, methods and practices of the Software engineering. Ability to identify, evaluate and manage potential risks that may occur. Ability to design appropriate solutions in one or more application domains using software engineering methods that integrate ethical, social, legal and economic aspects. Ability to actively participate in the specification, design, implementation and maintenance of information and communication systems.

6 ECTS credits.

2.2 Second Semester

2.2.1 Web Applications Development

Basic client side web technologies: HTML, CSS, JavaScript and REST APIs. Server side web technologies: Java, Spring and MySQL. Web applications deployment. Advanced client side web technologies: SPA with Angular.

6 ECTS credits.

2.2.2 Software Evolution and Adaptation

Introduction to Software Evolution and Maintenance. Software Configuration Management. Software Evolution Techniques. New Trends in Software Evolution.

2.2.3 Computer Security

Concepts and definitions. Risk management and incidents. Anatomy of an attack. IP network and protocol attack. Malware. Application and services attacks. Criptography. Network and protocol countermeasures. User, administrator and developer countermeasures. Present and future of Computer Security.

6 ECTS credits.

2.2.4 Human-Computer Interaction

Introduction to Human-Computer Interaction. Graphical elements of IUs. Design of User Interfaces. Usability. Accessibility. Evaluation of User Interfaces.

6 ECTS credits.

2.2.5 Software Quality

This course focuses on: developing software systems with quality attributes; explaining and using quality management methods.

6 ECTS credits.

3

Fourth Course

3.1 First Semester

3.1.1 Programming Paradigms

Introduction: Introduction to the Paradigms of Programming. Evolution and history Compilers, interpreters, and virtual machines. Functional Programming: Fundamentals of functional programming. Concept of function. Order of evaluation in expressions. Data types. Functions. Simple expressions. Tuples. Conditional expressions. Recursion. Pattern adjustment. Lists. Polymorphism. Programmer-defined data types, higher-order functions. Input/Output. Modular Programming. Input/Output actions. Modular programming. Multi paradigm Interpreted Languages: Dynamic/static typing. Dynamic Languages, portability and software development cycle. Python basic syntax. Data types and operators. Control structures. Lists and dictionaries. Characters, strings and regular expressions. Programming Paradigms with Python.

6 ECTS credits.

3.1.2 Mobile Devices Laboratory

This subject is only taught at Mostoles Campus.

Introduction: Ubiquitous Computing. Principles and Concepts. Mobile Computing. Types of Mobile Devices. Review of technologies and systems. Development of mobile applications: environments and programming languages. Application development and interaction with mobile devices. Development of User Interfaces for Mobile Devices. Persistent storage. Project creation. File manifest and AVD. Layout creation. Activity and View. Main Widgets. Android storage concepts. File systems. Preferences and other storage. Databases with mobile device. Advanced programming. Multimedia content management. Game programming for mobile devices. Multimedia concepts. multimedia APIs. Audio and video processing. Recording of contents. Animation and game programming.

6 ECTS credits.

3.1.3 Information Systems Engineering

The general objective of this course is the acquisition of the necessary competences to analyse the impact of a specific Information System within an organisation, as well as the acquisition of the necessary knowledge for its selection of a specific information system within an organisation, as well as acquiring the necessary knowledge for its selection, administration and management. Upon successful completion of this subject, students will be able to: conceive, deploy, organise and manage information systems in business or institutional contexts in order to improve. their business processes, as well as their implementation and continuous improvement. Build, integrate, install and maintain information systems in the context of an organisation. Actively participate in the specification, design, implementation and maintenance of information systems. Explain models and decision support systems based on data warehouses Integrate information technology solutions and business processes to meet the information needs of organisations. Determine the requirements of an organisation's information and communication systems taking into account aspects of organisations. Determine the requirements of an organisation's information and communication systems taking into account aspects of security and compliance with current regulations and legislation.

6 ECTS credits.

3.2 Second Semester

3.2.1 Concurrent Programming

Introduction to concurrent programming, Conditional synchronisation, Mutual exclusion, Active waiting, Passive waiting, Semaphore, Introduction to concurrent programming in Java, Monitors, Locks, Cyclic barriers, Parallel models such as fork/join and map/reduce.

6 ECTS credits.

3.2.2 Computer Graphics

Computer graphics. Image processing. Graphics pipeline. 3D Object representations. Methods and models. Geometric transformations. Geometrical transformations. Composition of transformations. Color. The human visual system. Color perception. Representation of color values. Illumination and Shading. The Phong Lighting Model. Shading models. Visual realism. Visible surface determination. Textures. Other methods.

6 ECTS credits.

3.2.3 Multimedia

Multimedia Technologies. HTML5. Foundations and characterization. Creation of a video game. Augmented Reality (AR). Foundations and characterization. Creation of an RA Project Accessibility: Accessible content. Foundations and characterization. Design of an accessible website

NOTE: To address the different topics, the introduction makes a brief reference to the media, in particular its characteristics and existing formats, given the importance of its use in the implementation of multimedia systems. On the other hand, different types of multimedia systems are developed in all topics, for which aspects of design (IPO), authorship and evaluation will be taken into account.

6 ECTS credits.

3.2.4 Databases Technologies

Database Technologies. Introduction to Data Engineering. General overview. Files. Semi-structured Databases. Advanced Data Models. Document Oriented Databases. Object-Relational Databases Data Warehouses. Multidimensional Structures. Busi-

ness Intelligence. ROLAP.

6 ECTS credits.