ECTS Information Package: Degree Programme

Master´s degree in

COMPUTER ENGINEERING - INTERNET OF THINGS

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A - General Description

Programme Title - Mestrado em Engenharia Informática-Internet das Coisas

Qualification awarded - Master´s degree in Computer Engineering - Internet of Things

Level of qualification - Second-cycle degree, EQF Level 7; ISCED Level 5

Specific admission requirements

General

According to the Portuguese Law, the following candidates are eligible for entry to the course of study leading to the *Mestre* degree:

- Holders of a *licenciado* degree or legally equivalent corresponding to the first cycle of higher education;
- Holders of a foreign higher degree awarded on completion of a first-cycle programme organised in the framework of the Bologna Process;
- Holders of a foreign higher degree which is deemed by the Technical-Scientific Committee of ESTT-IPT to meet the requirements of a *licenciado* degree.
- Holders of an academic, scientific or professional curriculum which is deemed by the Technical/Scientific Committee of ESTT-IPT as appropriate to access the programme.

Specific

Holders of a pre-Bologna degree (3-year Bacharelato or 5-year Licenciatura) or a Bologna Licenciatura in Computer Engineering or related areas (Electrical Engineering, Physical Engineering, Mechanical Engineering, and others).

Holders of an academic, scientific or professional curriculum which is deemed by ESTT?s Scientific Committee to meet the necessary requirements to access this study program.

Specific arrangements for recognition of prior learning (formal, non-formal and informal)

General
Granting of credits from prior learning is regulated by the Portuguese Law taking into account the level of credits and the field of study where they have been earned and is subject to the recognition of ESTT-IPT Technical/Scientific Committee.

- Training undertaken in the context of other higher education programmes of study from national or foreign HE establishments or organised in the framework of the Bologna Process or other prior learning can be credited towards the present programme of study;
- Credits earned from postgraduate studies can also be credited towards this programme of study;
- Professional experience or other training, different from the abovementioned ones, can also be credited towards this programme of study.

Specific
Allocation of credits to individuals holding a degree in Computer Engineering or similar programs prior to Bologna with a duration equivalent to 300 ECTS credits (5 years of study) is formally analysed on a case-to-case basis.

Qualification requirements and regulations:
Masters courses are regulated by the Portuguese legislation and by the regulatory standards of the master's courses defined by the School of Technology of Tomar.To complete the master's studies cycle it is necessary to obtain 120 ECTS Credits, distributed over 4 curricular semesters according to the curricular structure of the course.Each ECTS credit corresponds to 27 hours of total student work.

Profile of the program:
The Master´s degree in Computer Engineering - Internet of Things (MCE-IoT) has as main objective to provide professional and specialized training in the areas of intelligent systems, wireless sensor networks, software engineering and in the modern technologies and methodologies associated with science and programming technology .

The Master´s degree in Computer Engineering presents a new training approach focused on the new IoT paradigm, which will allow master studentsto obtain solid and practical training in the areas that support the development of IoT services and applications, in a training profile that allows the participation in projects integrating these technologies in companies.

Development and deployment of these technologies is supported in partnerships with several national companies of reference in these areas.

Key learning outcomes:
Graduates from this program are expected to be able to apply relevant concepts and techniques of: - development of IoT applications and services;- coordination and management of IoT projects;- processing and computing large volumes of data; - analysis and development of solutions for sensor networks;- specification of requirements and software development.

Occupational profiles of graduates with examples:
Holders of the master's degree in Computer Engineering will be prepared to integrate public entities and national reference companies that need specialized technicians in the areas of software engineering, intelligent systems and programming sciences with the following professional profile (among others): - development of IoT applications and services; - coordination and management of IoT projects; - processing and computing large volumes of data; - analysis and development of solutions for sensor networks; - specification of requirements and software development.

Access to further studies:

The master's degree in Computer Engineering gives access to third-cycle programs in areas of Computer Engineering and other related areas according to applicable admission regulations.

Course structure diagram with credits

Course Title	Year	Semester	Credits
Analysis and Processing of Big Data	1	S1	7.5
Artificial Intelligence	1	S1	7.5
Introduction to the Internet of Things and Embedded Systems	1	S1	7.5
Software Engineering	1	S1	7.5
Project Management in Computer Engineering	1	S2	7.5
Security on wireless sensor networks	1	S2	7.5
Virtualization and Cloud computing	1	S2	7.5
Wireless Sensor Networks	1	S2	7.5
	2	A	56
op: Internship	2	A	56
op: Project	2	A	56
Seminar	2	S1	4

(*) This course may not be available in certain academic years. Please confirm availability with the Erasmus coordinator.

Examination regulations, assessment and grading

General
Assessment of course units complies with the Academic Regulations in force at ESTT-IPT, except for the Dissertation, Project and Internship, to which apply the provisions set out in the regulations for the master's degrees offered by the ESTT-IPT.

- Dissertation, Project and Internship have only two assessment seasons and the students are free to choose only one.
- The assessment calendar for the Dissertation, Project and Internship is proposed by the Programme Coordinating Committee to the Technical/Scientific Committee at the beginning of each academic year.
- The general grade improvement scheme does not apply to the Dissertation, Project and Internship.

The overall grade of the master's programme is the arithmetic weighted average rounded off to the ones of the number of ECTS credits and the grades of the course units that form part of the programme of study.
The 10-20 mark expressed on a 0-20 scale is converted into its equivalent in the European grading scale with the awards Satisfactory, Good, Very Good or Excellent.

Specific

Graduation requirements:
The completion of the study cycle requires the approval of all the curricular units comprising it, including the public defense of the project work or the internship report, in order to obtain 120 ECTS credits according to the general and specific evaluation rules

Mode of study:
Full- or part-time. Evening program.

Program director or equivalente

Director: Ana Cristina Barata Pires Lopes
Erasmus coordinator: Gabriel Pereira Pires
ECTS coordinator: Gabriel Pereira Pires

B - Description of individual course units

Course unit title	Analysis and Processing of Big Data
Course unit code	39091
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Ricardo Nuno Taborda Campos
Learning outcomes of the course unit	1. Get familiarized with the 5 V?s of big data; 2. Understand the risks of using big data in what concerns to data privacy 3. Understand the lifecycle of a big data project and its architecture 4. Understand the architecture behind a big data system 5. Know how to extract and analyze information
Mode of delivery	----
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	1. Introduction to Data Science 2. Ethics and Data Privacy 3. Introduction to Big Data 4. Big Data Storage and Processing Framework: Apache Hadoop 5. Text Analytics with Python
Recommended or required Reading	- Provost, F. e Fawcett, T. e , . (2013). *Data Science for Business*. (pp. 1-386). USA: OÂ´Reilly - Witten, I. e Frank, E. e Hall, M. (2011). *Data Mining: Practical Machine Learning Tools and Techniques*. (pp. 1-629). USA: Elsevier - Erl, T. e Khattak, W. e Buhler, P. (2016). *Big Data Fundamentals: Concepts, Drivers & Techniques*. (pp. 1-235). USA: Prentice Hall - Davis, K.(2012). *Ethics of Big Data*. (pp. 1-79). USA: OÂ´Reilly
Planned learning activities and teaching methods	Theoretical and practical teaching with audiovisual media, laboratory equipment and practical examples. Assessement: Realization and presentation of group projects.
Assessment Methods and criteria	Periodic Assessment: Research Project (RP) (50%)+Hands-on Lab(50%) Students are excluded from the exam if they score < 4 points in either of the 2 assessment moments or if they do not reach a minimum of 70% of attendance. Final Evaluation: RP(100%)
Language of Instruction	Portuguese
Work placement(s)	Not applicable

B - Description of individual course units

Course unit title	Artificial Intelligence
Course unit code	39094
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Micael Santos Couceiro
Learning outcomes of the course unit	Understand the basis of artificial intelligence, focusing on (multi)agent theory, bio-inspired systems, optimization methods and problem solving, mathematical modeling and fuzzy logic decision-making, and in both traditional and deep learning classification.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	* Basic fundamentals of AI * Fuzzy logic to represent knowledge and reasoning * Support vector machines for learning * Deep Learning * Autonomous agents and multi-agent systems * Biomimetics and swarm intelligence to solve problems * Robotics
Recommended or required Reading	- Russell, S. e Novig, P. (2010). *Artificial Intelligence: a Modern Approach*. : Prentice-Hall - Baral, C.(2003). *Knowledge Representation, Reasoning and Declarative Problem Solving*. : Cambridge University Press - Wooldridge, M.(2009). *An introduction to MultiAgent Systems*. : John Wiley
Planned learning activities and teaching methods	* Theoretical-practical teaching resorting to audiovisuals, laboratory equipment and practical use cases * Evaluation through practical individual works and final group project
Assessment Methods and criteria	* The practical individual works correspond to a score of 10 (min. 5) * The final project corresponds to a score of 10 (min. 5) * Overall, the student needs a score of 10 to be approved.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable

B - Description of individual course units

Course unit title	Introduction to the Internet of Things and Embedded Systems
Course unit code	39093
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Ana Cristina Barata Pires Lopes Manuel Fernando Martins de Barros
Learning outcomes of the course unit	1. The aim of this unit is to develop skills in the field of embedded systems (ES) and Internet of Things (IoT) 2. To know the fundamental concepts, platforms and architectures of ES, WSN and IoT technologies; 3. Develop practical applications for IoT, WSN networks and web service applications.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	1. Introduction to the Internet of things: history, concepts, definitions and perspectives 2. Scenarios and IoT applications 3. Technology for wireless sensor networks (WSN) 4. Platforms for WSN networks 5. Embedded operating systems (SE) 6. Web Services: ThingSpeak, NodeRed, SicsthSense 7. Development of applications for WSN networks as Web services
Recommended or required Reading	- Atzori, L. e Morabita, G. (2010). The Internet of Things: A survey.*Comput. Netw. 54, 15*, pp. 2787-2805. - Sheng, Z. e Leung, K. (2013). A survey on the ietf protocol suite for the internet of things: standards, challenges, and opportunities.*IEEE Transactions on Wireless Communications, 20*, pp. 91-98. - Culler, D.(2006). TinyOS: Operating System Design for Wireless Sensor Networks.*Sensors, 1*, - Culler, D. e Srivastafa, M. (2004). Overview of Sensor Networks.*IEEE Computer Special Issue, 1*, - Colina, A. e Vives, A. (0). *Internet of Things in five Days*.Acedido em16 de outubro de 2018 em https://github.com/marcozennaro/IPv6-WSN-book
Planned learning activities and teaching methods	Lectures, Problem solving classes and Laboratory classes;
Assessment Methods and criteria	Lab performance (40%); Final project presentation and demo (20%); Final project report (20%); Bibliographic research and assessment tests (TP) (20%)
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Software Engineering
Course unit code	39092
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Renato Eduardo Silva Panda
Learning outcomes of the course unit	Educate the students about the different software engineering paradigms and models, namely agile software development methodologies, and its application in real world projects. Familiarization with new technologies and paradigms typically used nowadays.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable.
Recommended optional programme componentes	Not applicable.
Course contentes	Introduction to software engineering. Traditional and agile development models. Application of an Agile methodology to develop a software solution. Software development: Model-View-Controller paradigm (MVC), new frameworks, APIs and SPAs, ORM systems, code versioning systems, code review and continuous integration, automated software testing.
Recommended or required Reading	- Ruby, S.(2016). *Agile Web Development with Rails 5*. US: Pragmatic Bookshelf - Sutherland, J. e Schwaber, K. (0). *The definitive guide to scrum: the rules of the game*.Acedido em21 de novembro de 2018 em https://www.scrum.org/resources/scrum-guide
Planned learning activities and teaching methods	Theoretical classes introducing new topics (based on syllabus), tutorials on new technologies, workshops and oral presentations. Laboratory / practical sessions used for project development and support.
Assessment Methods and criteria	Theoretical (25%) - Closed book exam. Minimum grade of 35% required. Practice (75%) - Continuous evaluation of a project carried out by the students, including their performance over the various iterations, product presentation and documentation.
Language of Instruction	Portuguese | **Mentoring in** English
Work placement(s)	Not applicable.

B - Description of individual course units

Course unit title	Project Management in Computer Engineering
Course unit code	39098
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Nuno José Valente Lopes Madeira
Learning outcomes of the course unit	The curricular unit aims to familiarize students with how different existing methodologies for software development, namely agile methodologies, and their application, equipping them with the necessary skills to design a real project.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	a) Introduction to software engineering b) Management and project planning c) Team management and organization d) Documentation, testing and quality assurance e) Sequential, iterative or incremental and agile development models f) Introduction to agile, development in short periods g) Practical implementation of agile methodologies h) Use of col aborative tools
Recommended or required Reading	- Sommerville, I.(2011). *Software engineering* . (Vol. 1). (pp. 1---). USA: Addison-Wesley - Shore, J. e Warden, S. (2010). *The art of Agile Development*. (Vol. 1). (pp. 1---). USA: O'Reilly Media - McConnel, S.(2014). *Code Complete: A Practical Handbook of Software Construction*. (Vol. 1). (pp. 1---). USA: Microsoft Press
Planned learning activities and teaching methods	The course includes theoretical and practical lectures, in which the programme contents will be provided regarding the accomplishment of the objectives. Several computational tools will be used to carry out exercises in laboratorial context.
Assessment Methods and criteria	Continuous Evaluation (40%) Participation in class, work in classroom context Written Assessment (60%) Frequency / Examination / Examination of Appeal
Language of Instruction	Portuguese
Work placement(s)	Not applicable

B - Description of individual course units

Course unit title	Security on wireless sensor networks
Course unit code	39096
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Luís Miguel Lopes de Oliveira
Learning outcomes of the course unit	know the main threats to the security of sensor networks Know the security mechanisms best suited to sensor networks. develop Security solutions for sensor networks according to the service Detect and prevent security attacks Identify the WNS' ethical, social and social and legal problems.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not Applicable
Recommended optional programme componentes	Not Applicable
Course contentes	a) Identification of the main threats to data and systems in sensor networks b) Know the most suitable security solution to wireless sensor networks. c) Build security solutions according to WSN constrains. d) Detect and prevent agains security attacks e) Identify ethical, social and legal problems related to WSN.
Recommended or required Reading	- Shafiullah , .(2013). *Wireless Networks and Security*. Berlin : Springer Berlin Heidelberg
Planned learning activities and teaching methods	theoretical sessions to present and discuss the main concepts and laboratory sessions to solve real problems related with WSN and its services.
Assessment Methods and criteria	The assessment is based on two components: i) theoretical (40%) and practical (60%).
Language of Instruction	Portuguese
Work placement(s)	Not Applicable

B - Description of individual course units

Course unit title	Virtualization and Cloud computing
Course unit code	39095
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	
Learning outcomes of the course unit	To understand the basic fundamentals of virtualization. To learn the different types of virtualization and cloud computing. To understand the needs of the physical infrastructure of a cloud support. To be able to develop a scalability strategy.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	Surrounding physical infrastructure. Theoretical essentials of virtualization and cloud computing. Cloud architectures and classification Layers of cloud infrastructures and respective interconnection Operating systems and infrastructure associated with cloud computing. Solution scalability and associated infrastructure.
Recommended or required Reading	- J. Kavis, M.(2014). *Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)*. (Vol. --). --: Wiley
Planned learning activities and teaching methods	Theoretical and practical classes.
Assessment Methods and criteria	The evaluation of the curricular unit will be focused on the development and presentation of a practical work, in the expected exam seasons, in the field of cloud infrastructures. The evaluation components must include a report of the developed work, and a presentation of the work. The developed solution has a weight of 60%, the report has a weight of 30% and the presentation has a weight of 10%.
Language of Instruction	Portuguese
Work placement(s)	Not applicable

B - Description of individual course units

Course unit title	Wireless Sensor Networks
Course unit code	39097
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	First Year
Semester/Trimester when the course unit is delivered	Second Semester
Number of ECTS credits allocated	7.5
Name of Lecturer(s)	Luís Miguel Lopes de Oliveira Ana Cristina Barata Pires Lopes
Learning outcomes of the course unit	a) know the constraints of a sensor network. b) Apply media access methods best suited to each situation. c) Develop wireless sensor networks using the most suitable layer protocols. d) Manage Wireless sensor networks.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	a) know the constraints of a sensor network. b) Choose the most suitable medium access layer c) Know the WSN' routing protocols d) Build WSN using the most suitable protocols of each layer e) Manage WSNs f) Identify and solve issues and malfunction situations on WSNs
Recommended or required Reading	- Shuang-Hua, Y.(2014). *Wireless Sensor Networks Principles, Design and Applications*. London: Springer-Verlag London
Planned learning activities and teaching methods	Theoretical sessions to present and discuss the main concepts and laboratory sessions to solve real problems related with WSN and its services.
Assessment Methods and criteria	The assessment is based on two components: i) theoretical (40%) and practical (60%).
Language of Instruction	Portuguese
Work placement(s)	Not applicable

B - Description of individual course units

Course unit title	Internship
Course unit code	390912
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	Anual
Number of ECTS credits allocated	56
Name of Lecturer(s)	Vários
Learning outcomes of the course unit	1. To know business world reality in the field of projects and solutions in the areas of Internet of Things. 2. To be able to handle the organization and development of a long or medium term complex project.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	1. The contents vary from student to student depending on the project or internship site.
Recommended or required Reading	
Planned learning activities and teaching methods	Project or internship progress monitoring by the supervisors
Assessment Methods and criteria	Presentation of a final written report before a jury, followed by discussion.
Language of Instruction	Portuguese
Work placement(s)	This curricular unit consists of an internship

B - Description of individual course units

Course unit title	Project
Course unit code	390911
Type of course unit	Optional
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	Anual
Number of ECTS credits allocated	56
Name of Lecturer(s)	Vários
Learning outcomes of the course unit	1. To know business world reality in the field of projects and solutions in the areas of Internet of Things. 2. To be able to handle the organization and development of a long or medium term complex project.
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	The contents vary from student to student depending on the project.
Recommended or required Reading	
Planned learning activities and teaching methods	Project or internship progress monitoring by the supervisors.
Assessment Methods and criteria	Presentation of a final written report before a jury, followed by discussion.
Language of Instruction	Portuguese
Work placement(s)	Not applicable

B - Description of individual course units

Course unit title	Seminar
Course unit code	39099
Type of course unit	Compulsory
Level of Course unit	Second Cycle
Year of Study	Second Year
Semester/Trimester when the course unit is delivered	First Semester
Number of ECTS credits allocated	4
Name of Lecturer(s)	Ana Cristina Barata Pires Lopes
Learning outcomes of the course unit	To know the main technologies currently used in IoT and the best practices to develop services and applications for IoT; To acquire experience to analyze the main aspects related to security applied to the Internet of Things;
Mode of delivery	Face-to-face
Prerequisites and co-requisites	Not applicable
Recommended optional programme componentes	Not applicable
Course contentes	1. Emerging technologies for the development of IoT applications and services. 2. Security applied to the Internet of Things.
Recommended or required Reading	- Atzori, L. e Morabito, G. (2010). The Internet of Things: A survey. .*Comput. Netw*, *54*, pp. 2787-2805.
Planned learning activities and teaching methods	workshops with IoT experts
Assessment Methods and criteria	This curricular unit consists of workshops, covering the programmatic content (with invited speakers). Students will be assessed through research reports and oral presentation
Language of Instruction	Portuguese
Work placement(s)	Not applicable