Course Name : Internet of Things (Basics)

Course Code	Course Type	Regular Semester	Lecture (hours/week)	Seminar (hours/week)	Lab. (hours/week)	Credits	ECTS
CMP 412	C	Spring	3.00	1.00	0.00	3.50	6.00

Lecturer	Denard Veshi, Prof. Asoc. Dr.
Assistant	Edlir Spaho, MSc
Course language	Albanian
Course level	Master
Description	The Internet of Things (IoT) course covers the knowledge needed to understand and build IoT-based real-world applications using a variety of hardware and software components. The course will be oriented towards the practical realization of theoretical knowledge to equip students with basic practical knowledge for the implementation of IoT-based systems in various fields, the management of data generated by these systems and the well-being of privacy and security in these systems.
Objectives	This course aims to: 1. Familiarize students with the basic components of IoT. 2. Introduce students to the different techniques and ways of using IoT components. 3. Explain the importance and influence of IoT in new technological developments 4. To develop students' critical thinking in analyzing and finding and creating best IoT-based models.
Core Concepts	1. Things 2. Smart Objects 3. Edge Computing 4. Fog Computing 5. Arduino 6. Raspberry Pi 7. Data management in the IoT 8. Communication protocols in the IoT 9. Privacy and Security in the IoT 10. ROS, Blockchain, Ethernum

Course Outline

Week	Topic
1	Introduction to Internet of Things (IoT) In this topic there will be a general presentation of IoT, where among the main topics that will be addressed are: What is IoT ?, IoT genesis, IoT and Digitization, the impact of IoT, the konvergence of IT with IoT, IoT Applications as well as IoT challenges. (Literature 1 pp. 47– 74)
2	Basic Components of an IoT System In this topic will include a general presentation of "Thing" in IoT, IoT Infrastructure Technologies that enable IoT, Mobility - as a new Paradigm for IoT Systems and IoT data management aspects. (Literature 2 Pages 20 - 27)
3	IoT Network Architecture and Design The following topics will be addressed in this lecture. Promoters of new network architectures, Comparison of IoT architectures, Introduction of a simplified IoT architecture, IoT Basic Functional Stack as well as IoT Data Management and Compute Stack (Literature 1 Pages 75 - 133)
4	Intelligent Objects: The "Things" in IoT In this topic will treate Sensors (clasification criteries, categories and some types for each category), Activators (clasification criteries, categories and some types for each category) the main features of Intelligent Objects and Sensors Networks (Literature 1 Page 136 - 161)
5	Connecting Intelligent Objects (Communication Criteria) This topic will address the communication criteria that should be considered for the connection of intelligent objects such as Range, Frequency Bands, Power Consumption, Topology, Limited Devices (Constrained Devices) as well as Constrained-Node Networks (Literature 1 Pages 162 - 177)
6	Connecting Intelligent Objects (IoT Access Technologies) Among the main topics that will be addressed in this topic are the main IoT access technologies such as IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN, NB-IoT and other variations of LTE (Literature 1 Pages 178 - 232)

7	Edge and Fog Computing In this topic a detailed description of one of the most used IoT devices which is Arduino will be treated. Topics to be covered include Digital Input / Output Pin, Pulse Modulation Width, Analog Pin, Power Pin and other pins, Memory, Interface and board size, Arduino shields, sensors, drivers, configuration and programming of Arduino as well as various examples of Arduino implementation in the IoT (Literature 2 Pages 28 - 106)
8	Midterm Exam
9	Edge and Fog Computing Among the main topics to be covered in this topic are Raspberry Pi General Information, Raspberry Pi Sensors, Raspberry Pi Drivers, a general introduction to the Raspberry Pi operating system, the basics of programming in the Rasbian and Windows 10 Operating System IoT Core as well as various examples of Raspberry Pi implementation in IoT. (Literature 2 Pages 164 - 262)
10	Data and information management in the IoT This topic will address the IoT data lifecycle, IoT Data Management versus traditional database management systems, IoT data sources, main IoT data-generating fields, infrastructure, and architectures for IoT data processing such as: Cloud, Fog, and Edge Computing. Also this topic will address IoT data storage and processing models, Data Semantics and their visualization in IoT. (Literature 2 Pages 290 - 302)
11	Security and Privacy in IoT This topic will address the IoT Vulnerability Types, Vulnerability Monitoring, IoT Malware Detection, IoT Security Protocols, IoT Privacy and Privacy Protection, IoT Privacy Risks, Confidentiality and Authentication Methods. (Literature 2 Pages 303 - 331)
12	Energy consumption in IoT This topic will address an Introduction to IoT Energy Consumption, IoT Energy Efficiency, Minimum Energy Performance Standards (SMPE), Vertical Structure Organization, Horizontal and Grouped SMPEs, Electronic Components and their power requirements: Engines, Sensors, Microcontrollers, IoT Software Platform and IoT Battery Management Systems will oalso be treated. (Literature 2 Pages 332 - 336)
13	Future IoT Technologies ROS - A New Model in IoT, What is ROS? , ROS Features, Operating System, ROS Architecture, Introduction to ROS Programming, IoT Bridge, Autonomous Transport Systems, Blockchain and Ethernum. (Literature 2 Pages 337 - 360)
14	Projects Presentation
15	Projects Presentation and Review
16	Final Exam

Prerequisites	The student must attend the course at a minimum rate of 75%.
Literature	• Literatura - 1: IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, ISBN-13: 978-1-58714-456-1 (2017) • Literatura - 2: Introduction to the IoT, IOT-OPEN.EU, Project number: 2016-1-PL01-KA203-026471
References	•

Course Outcome

1	Students will have a good knowledge of main IoT hardware devices as well as IoT communication protocols used to build IoT-based systems.
2	Students will have knowledge on using main IoT tools.
3	Students will master the most important concepts regarding building an IoT-based system and managing the data generated by it.
4	Students will be able to understand the strengths and weaknesses of many well-known approaches of IoT-based systems.
5	Students will be ready to implement IoT-based systems in practice in a wide range of real-world applications.
6	Students will be equipped with sufficient theoretical and practical knowledge to pursue other subjects that focuses on IoT.

Course Evaluation

In-term Studies	Quantity	Percentage
Midterms	1	30
Quizzes	0	0
Projects	1	30
Term Projects	0	0
Laboratory	0	0
Class Participation	0	0
Total in-term evaluation percent		**60**
Final exam percent		**40**
Total		**100**

ECTS Workload (Based on Student Workload)

Activities	Quantity	Duration (hours)	Total (hours)
Course duration (Including the exam week: 16x Total hours of the course)	16	4	64
Study hours outside the classroom (Preparation, Practice, etc.)	14	4	56
Duties	1	9	9
Midterms	1	9	9
Final Exam	1	12	12
Other	0	0	0
Total Work Load			**150**
Total Work Load / 25 (hours)			**6.00**
ECTS			**6.00**