COURSE DESCRIPTION

Approval: 24th Senate Meeting

Course Name: IoT Systems

Course Number: EE536

Credits: 2-0-2-3

Prerequisites: Communication theory (EE304); Computer networks (CS406); Microcontroller programming and Digital systems design (IC161)

Intended for: B.Tech. III/IV year/ MS/M.Tech./PhD

Distribution: Core for M.Tech. (CSP)

Semester: Even

Preamble: The Internet of things can be seen as an agglomeration of various technologies that facilitate data acquisition, device-to-device communication, real-time monitoring and actuation for several real-world applications. The objective of this course is to introduce the students to some of these constituent technologies and provide them hands-on experience in designing small-scale IoT systems. While the emphasis is given on the implementation aspects, the students will be briefed about the underlying theoretical concepts. They will be also introduced to several performance metrics that can be used to evaluate different IoT systems.

Learning outcome: After taking this course, students will

1. be familiar with different prototyping boards and their components. They will be able to choose an appropriate board/components for designing an IoT system.
2. have hands-on experience in programming off-the-shelf boards using respective IDEs. Additionally, they will be able to choose appropriate libraries for interfacing with external sensors, or communication modules.
3. be versed in different communication standards and technologies. They will be able to choose appropriate communication technology/technologies for designing an IoT system.
4. be knowledgeable about Medium Access Protocols, routing algorithms and their implementations.
5. be able to compare different IoT systems in terms of different performance metrics: network lifetime, power consumption, reliability of the network etc.
6. be able to design a small-scale IoT system for several real-world applications.

Course modules:

1. *An introduction to IoT systems:* (1 lecture hour)
   Introduction and motivation of IoT systems

2. *Hardware components of IoT systems:* (2 lecture hours + 2 lab hours)
   A quick overview of different components---micro-controllers, SoCs, communication modules, power supply and sensing modules---of off-the-shelf prototyping boards, e.g., Arduino UNO, MSP430 LaunchPad; NodeMCU, STM32, Raspberry Pi.

3. *Software component of IoT systems:* (6 lecture hours + 6 lab hours) Introduction to IDEs for off-the-shelf boards, e.g., Arduino IDE, Waspmote IDE, Code composed studio; Contiki-OS and RIOT OS; 6LowPAN network stack; Sensor interfacing; GPIO programming

4. *Communication paradigm of IoT systems:* (12 lecture hours + 12 lab hours) Different wireless standards, e.g., IEEE802.15.4, ZigBee, BLE, IEEE802.11; link layer technologies, Medium Access Control; Routing; Application layer protocols; Network topologies.

5. *Performance evaluation of IoT systems:* (4 lecture hours + 4 lab hours) Developing mathematical models for energy consumption, Optimal node placement, resource allocation over wireless sensor networks to meet QoS requirements.

6. *Case studies/mini projects:* (3 lecture hours + 4 lab hours) Home automation; Building energy management; Indoor positioning; Air quality monitoring; Precision agriculture; Smart parking

Textbooks:

1. David Hanes *et al.*, *IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things*, First edition, Pearson, 2017

Reference Books:

1. Parry Lea, *Internet of Things for Architects: Architecting IoT Solutions by Implementing Sensors, Communication Infrastructure, Edge Computing, Analytics, and Security*, Packt Publishing Limited, 2018
2. Shuang-Hua Yang, *Wireless Sensor Networks: Principles, Design and Applications*, Springer.
3. Kazem Sohraby, Daniel Minoli, Taieb F. Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley Interscience, 2009
4. White papers, RFCs, survey articles on Wireless communication standards and technologies.
5. Antonio Linan Colina, Alvaro Vives, Antoine Bagula, Marco Zennaro and Ermanno Pietrosemoli, *IoT in five Days*, https://github.com/marcozennaro/IPv6-WSN-book/releases/

Similarity Content Declaration with Existing Courses:

Sr #	Course code	Similarity content	Approx. % of content
1	Embedded Systems (EE529)	Sensor control using Micro controllers	10%
2	IoT systems and Cloud (CS541P)	Microcontroller programming, device-to-device communication, wireless technologies (this is a practicum course)	10%

Justification for new course proposal if cumulative similarity content is > 30%: N.A.