Third Engineering-E&TC (2015 Course)

(With effect from Academic Year 2017-18)

Semester I												
Course Code	**Course**	**Teaching Scheme Hours / Week**			**Semester Examination Scheme of Marks**						**Credits**	
		Theory	**Tutorials**	**Practicals**	**In-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH/TW**	**PR+OR**
304181	Digital Communication	4	--	--	30	70	--	--	--	100	4	--
304182	Digital Signal Processing	4	--	--	30	70	--	--	--	100	4	--
304183	Electromagnetics	3	1	--	30	70	--	--	--	100	4	--
304184	Microcontrollers	3	--	--	30	70	--	--	--	100	3	1
304185	Mechatronics	3	--	--	30	70	--	--	--	100	3	1
304191	Signal Processing and Communications Lab (DC/DSP)	--	--	4	--	--	50	50		100	--	2
304192	Microcontrollers and Mechatronics Lab	--	--	4	--	--	50	50		100		
304193	Electronics System Design	2	--	2	--	--	-	--	50	50	2	1
	Audit Course 3	--	--	--	--	--	--	--	--	--	----	
	Total	19	1	10	150	350	100	100	50	750		
										Total Credits	**25**	

Third Engineering-E&TC (2015 Course)

(With effect from Academic Year 2017-18)

Semester II												
Course Code	**Course**	**Teaching Scheme Hours / Week**			**Semester Examination Scheme of Marks**						**Credit**	
		Theory	**Tutorials**	**Practicals**	**In-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH/TW**	**PR +OR**
304186	Power Electronics	4	--	--	30	70	--	--	--	100	4	--
304187	Information Theory, Coding and Communication Networks	4	--	--	30	70	--	--	--	100	4	--
304188	Business Management	3	--	--	30	70	--	--	--	100	3	--
306189	Advanced Processors	4	--	--	30	70	--	--	--	100	4	1
304190	System Programming and Operating Systems	3	--	--	30	70		--	--	100	3	1
304194	Power and ITCT Lab	--	--	4	--	--	50	50	--	100	--	2
304195	Advanced Processors and System Prograaming. Lab	--	--	4	--	--	50	50	--	100		
304196	Employability Skills and Mini Project	2	--	2	--	--	--	--	50	50	2	1
	Audit Course 4	--	--	--	--	--	--	--	--	--		
	Total	20	---	10	150	350	100	100	50	750		
										Total Credits	**25**	

Savitribai Phule Pune University

Honours* in Internet of Things

Third Year of Engineering (Semester V)

310601: Embedded System and Internet of Things

Teaching Scheme:	Credit:	Examination Scheme:
Theory : 04 Hours/Week	04	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Companion Course, if any: - Embedded System and Internet of Things Laboratory

Course Objectives:

The main objective of this course is to introduce the students to basics of embedded systems and Internet of Things.

- To learn and understand the basics of Embedded systems.
- To be acquainted with interfacing of sensors and actuators with microprocessor.
- To design embedded systems applications.
- To understand Internet of Things and its usefulness for society.

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Identify and understand the unique characteristics and components of embedded systems

CO2: Compare various development boards Arduino, Raspberry pi, Beagle bone

CO3: Implement interfacing of various sensors, actuators to the development boards

CO4: Design, implement and test an embedded system application

CO5: Configure U-Boot, Understand IoT building blocks

CO6: Compare various IoT communication technologies and Design various IoT applications

#Exemplar/ Case Studies- Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. **Exemplar/Case Studies** may be assigned as self-study by students and to be excluded from theory examinations.

Course Contents

Unit I	ES Overview	(08 Hours)

Embedded Systems: Architecture & Characteristics of ES, Types of Embedded systems, Examples of Embedded Systems. Embedded System On Chip (SOC).

Components of ES: Hardware and software

Hardware components of ES: Power supply: types, characteristics, selection criteria, Procesing Unit,**Input devices, Output Devices**

Unit II	Introduction to ES System Software	(07 Hours)

Introduction to Embedded operating Systems: Operating Systems Concepts, Real time operating systems, and, Task Scheduling, Different OS tasks, Introduction to **Real-Time Operating Systems**, characteristics, selection criteria, bootloader: U-boot.

#Exemplar/ Case Studies	Case study: Raspberry Pi OS

Unit III	Sensors, Actuators and Interfacing	(09 Hours)

Sensors : Roles of Sensors & Actuators, Types of sensors ,Active and passive, analog and digital, Contact and no-contact, Absolute and relative **Working of Sensors**: Position, occupancy and motion, velocity and acceleration, force, pressure, flow, Acoustic, Humidity, light, radiation, temperature, chemical, biosensor, camera. **Development boards**: Types of boards - Arduino, Raspberry pi, Beagle bone, ESP8266, selection criteria. **Interfacing of sensors with development boards**.		
Unit IV	**Embedded System - Application Development**	(08 Hours)
Integrated Development Platforms for Application Development in ES environment, SDLC-Requirements, Architecture, Design, Components, Coding, Testing and Deployment. Study of any two Open source IDE for ES application development with respect to any of the two indicated Case studies		
#Exemplar/ Case Studies	**Design and development of ES Applications:** Object detection, Traffic signal, digital clock, robotics arm movement, fire alarm, automated disinfection tent, Bus ticketing system, Tyre pressure monitoring system, smart metering.	
Unit V	**IoT**	**(08 Hours)**
Introduction of IoT: Definition and characteristics of IoT, Technical Building blocks of IoT, Device, Communication Technologies, Data, Physical design of IoT, IoT enabling technologies, IoT Issues and Challenges- Planning, Costs and Quality ,Security and Privacy, Risks		
#Exemplar/ Case Studies	**Smart Home:** Characteristics of Smart Home - Smart Home Energy Management, Smart Appliances, Communication Technologies for Smart Homes, maintenance, security, challenges. **Smart Agricultural**: characteristics and applications -Scarecrow, Smart Irrigation System, Crop Water Management, Integrated Pest Management, Sensor-based field and resource mapping, Remote equipment monitoring)	
Unit VI	**Communication under IoT**	**(08 Hours)**
IoT Protocols:MQTT, CoAP, XMPP and AMQT, IoT communication models, **IoT Communication technologies**: Bluetooth, BLE, Zigbee, Zwave, NFC, RFID, LiFi, Wi-Fi, Interfacing of wifi, RFID, Zigbee,NFC with development board.		
#Exemplar/ Case Studies	**e-health**: Characteristics of e-health and applications- monitoring of health parameters, smart medicine box, elderly people monitoring, challenges. **IoT Smart City**: Characteristics and applications– Smart Economy, Smart People, Smart Goverence, Smart Mobility, Smart Environment, Smart Living Smart Grid, Smart Home, Transport and Traffic Management, Smart Healthcare	

Learning Resources

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515.
2. Lyla B. Das, "Embedded Systems: An Integrated Approach" Pearson , ISBN: 9332511675, 9789332511675

Reference Books:

- Sriram V. Iyer, Pankaj Gupta, "Embedded Real-time Systems Programming", Tata McGraw-Hill, ISBN: 13: 9780070482845
- David Hanes, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 2017
- Raj Kamal, "Embedded Systems: Architecture, programming and Design", 2nd Edition, McGraw-Hill, ISBN: 13: 9780070151253
- Olivier Hersent, Omar Elloumi and David Boswarthick, "The Internet of Things: Applications to the Smart Grid and Building Automation", Wiley, 2012, 9781119958345 3.
- Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012, ISBN:978-1-119-99435-0

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Savitribai Phule Pune University
Honours* in Internet of Things
Third Year of Engineering (Semester V)
310602: Embedded System and Internet of Things Laboratory

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Practical: 02 Hrs/Week	**01**	**Term Work:** 50 Marks

Companion Course : Embedded Systems and Internet of Things

Course Objectives:

- To understand the fundamentals and functionality of various embedded board platforms.
- To design and implement interconnection and integration of sensors to embedded board platform.
- To design and implement application of IoT using various sensors.

Course Outcomes:

On completion of the course, student will be able to–

- Understand the working of embedded boards.
- Apply the knowledge to interface various sensors with IoT development board.
- Design and implement IoT system for real time applications.

Guidelines for Laboratory Conduction

- **Lab Assignments:** Following is list of suggested laboratory assignments for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
- **Term Work**–Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. It is recommended to conduct internal monthly practical examination as part of continuous assessment.
- **Assessment:** Students' work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.
- **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Suggested List of Laboratory Experiments/Assignments

Student should perform at least 10 experiments with all experiments from group A and any 5 assignments from group Band one from group C assignments.

(Use suitable programming language/Tool for implementation)

Sr. No.	Group A
1.	Study of Raspberry Pi 4, Arduino board and Operating systems for the same. Understand the process of OS installation on the Raspberry Pi.
2.	Study of different sensors:- temperature sensor, bio-sensor, IR sensor, chemical sensor(PH), gauge sensor, ultrasonic sensor etc.
3.	Understand the connection and configuration of GPIO and its use in programming. Write an application of the use of push switch and LEDs.
4.	Write an application to read temperature from the environment. If temperature crosses threshold value then it notifies with buzzer.
	Group B
5.	Interface IR sensor to Raspberry Pi/ Arduino. Write a program to detect obstacle using IR sensor and notify it using LED.
6.	Understanding and connectivity of Raspberry-Pi /Beagle board with a Zigbee module. Write a network application for communication between two devices using Zigbee to on and off remote led.
7.	Interface stepper motor and seven segment display with Raspberry Pi/Arduino and write a program to control the motion of motor and display number of rotation made by motor on 7 segment display.
8.	Write an application using Raspberry Pi/Arduino for streetlight control system. System consists of smart street lights that have external light sensing that automatically turns on at desired intensity based on amount of lighting needed.
9.	Write an application using Raspberry Pi/Arduino for traffic signal monitoring and control system.
10.	Write an application using Raspberry Pi/Arduino for smart health monitoring system which records heart beat rate and temperature and also sends sms alerts if readings are beyond critical values.
11.	Implement a weather monitoring system using humidity, temperature and raindrop sensor and Raspberry Pi/Arduino board.
12.	Create a simple web interface for Raspberry-Pi/Beagle board to control the connected LEDs remotely through the interface.
	Group C
13.	Internet of things enabled real time water quality monitoring system
14.	Implement smart home automation system. The system automates home appliances and control them over internet from anywhere.
15.	Develop a Real time application like a smart home security. **Description**: When anyone comes at door the camera module automatically captures his image and sends a notification to the owner of the house on his mobile phone using GSM modem.

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Savitribai Phule Pune University
Honours* in Internet of Things
Third Year of Engineering (Semester V)
310603: Internet of Things Architectures, Protocols and Systems Programming

Teaching Scheme	Credits	Examination Scheme:
TH: 04 Hrs/week	04	In Semester Assessment: 30 End Semester Assessment: 70

Prerequisite: Computer Networks, Embedded Systems

Course Objectives

Objective of this course is to provide students with

1. The knowledge and understanding of Internet of Things
2. Provide a strong foundation of fundamentals of Internet of Things and need of IoT Security
3. Get acquainted with various communication protocols of Internet of Things
4. Detailed understanding of present scope of Internet of Things with case studies

Course Outcomes

1. Model Internet of Things using various protocols of standard communication layers
2. Represent and analyze various communication models, carry out the comparative analysis in terms of specified parameters
3. Choose an appropriate communication model for given design criteria
4. Understand essentials of IoT Security
5. Provide most optimum model of connectivity solution to various things in different application areas.

Course Contents

Module I	**Introduction to Internet of and Things (IoT)**	**10 Hrs**

Introduction: Enabling Technologies of IoT, Logical Design of IoT, IoT communication Models, IoT Communication API's

Cloud Services: IAAS, PAAS, SAAS, IoT Specific Cloud Services

RFID: Introduction to RFID and its Applications in IoT.

Module II	**Key Protocols-1**	**8 Hrs**

PHY/MAC Layer: Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy

Network Layer: IPv4, IPv6, 6LoWPAN, ICMP, RPL,COAP

Module III	**Key Protocols- 2**	**8 Hrs**

Transport Layer: (TCP, UDP, DCCP, SCTP)-(TLS, DTLS) **Session Layer:** HTTP, CoAP, XMPP, AMQP, MQTT		
Module IV	**IoT Security**	**6Hrs**
Vulnerabilities Security Requirements and Threat Analysis, Misuse Cases, IoT Security Tomography, and Layered Attacker Model, Identity Management and Establishment, Access Control, and Secure Message Communication, Security Models, IoT Security Protocols.		
Module V	**System Software for IoT**	**6Hrs**
Software for IoT Development Boards like Arduino, Raspberry Pi, Beagle Bone, Intel Galileo: IDE, Simulator, Emulator, Debugger, OS , Software Libraries for Internet connectivity Devices, Gateways, Internet, and Web/Cloud Services Software Development Prototyping Online Component API and Web APIs		
Module IV	**IoT Case Studies**	**7 Hrs**
Smart Cities, Agriculture, Health and Lifestyle, Industry, Home Automation, Telecom/5G.		
Text Books		
1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on Approach)", University Press 1st Edition, 2014 2. Jeeva Jose, "Internet of Things", ISBN-10 : 938617359X, Khanna Book Publishing, 2018 3. Raj Kamal, Internet of Things: Architecture and Design Principle" , ISBN-13: 978-93-5260-522-4, McGraw Hill Education (India) 2017		
Reference Books		
1. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning 2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally 3. HakimaChouchi, "The Internet of Things Connecting Objects to the Web", ISBN 078 -1-84821-140-7, Wiley Publications Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010. 4. Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition 5. Data and Computer Communications; By: Stallings, William; Pearson Education Pte.Ltd., Delhi, 6th Edition		
Relevant MOOCs Course		
NPTEL- Introduction to internet of things - Course (nptel.ac.in) Coursera An Introduction to Programming the Internet of Things (IOT) | Coursera		

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