Faculty of Science and Technology
Savitribai Phule Pune University
Maharashtra, India

http://unipune.ac.in

Honours* in **Internet of Things**

Board of Studies
(Computer Engineering)

(with effect from A.Y. 2020-21)

Savitribai Phule Pune University

With effect from 2020-21

Honours* in Internet of Things

Year & Semester	Course Code	Course Title	Teaching Scheme Hours / Week			Examination Scheme and Marks						Credit Scheme		
			Theory	Tutorial	Practical	Mid-Semester	End-Semester	Term work	Practical	Presentation	Total Marks	Theory / Tutorial	Practical	Total Credit
TE & V	310601	Embedded Systems and Internet of Things	04	--	--	30	70	--	--	--	100	04	--	04
	310602	Embedded Systems and Internet of Things Laboratory	--	--	02	--	--	50	--	--	50	--	01	01
	Total		04	-	02	100		50	-	-	150	04	01	05
										Total	**Credits =**		**05**	
TE & VI	310603	Internet of Things Architectures, Protocols and Systems Programming	04	--	--	30	70	--	--	--	100	04	--	04
	Total		04	-	-	100		-	-	-	100	04	-	04
										Total	**Credits =**		**04**	
BE & VII	410601	Machine Learning for Internet of Things	04	--	--	30	70	--	--	--	100	04	--	04
	410602	Machine Learning for Internet of Things Laboratory	--	--	02	--	--	50	--	--	50	--	01	01
	Total		04	-	02	100		50	-	-	150	04	01	05
										Total	**Credits =**		**05**	
BE & VIII	410603	Internet of Things Security	04	-	--	30	70	--	--	--	100	04	--	04
	410604	Seminar	--	02	--	--	--	-	--	50	50	02	--	02
	Total		04	-	02	100		-	--	50	150	06	-	06
										Total	**Credits =**		**06**	
Total Credit for Semester V+VI+VII+VIII = 20														

*** <u>To be offered as Honours for Major Disciplines as–</u>**

1. Computer Engineering

2. Electronics and Telecommunication Engineering

3. Electronics Engineering

4. Information Technology

<u>For any other Major Disciplines which is not mentioned above, it may be offered as Minor Degree.</u>

Reference: https://www.aicte-india.org/sites/default/files/APH%202020_21.pdf / page 99-100

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		

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.

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

Savitribai Phule Pune University, Pune
Honours* in Internet of Things
Fourth Year of Engineering (Semester VII)
410601: Machine Learning for Internet of Things

Teaching Scheme:	Credit:	Examination Scheme:
TH: -- 4 Hours/Week	4	**In-Sem (paper): - 30Marks** **End-Sem (paper): - 30 Marks**

Prerequisites: Microprocessor, Computer Network, Embedded System & IOT

Course Objectives:

The main objective of this course is to introduce the students to the basics of Machine Learning Concepts applicable with Internet of Things.

- To learn and understand the basics of Machine Learning and IoT
- To get acquainted with machine learning for IOT Data Analysis.
- To learn and understand Machine learning and deep learning methods for IoT applications.
- To design IoT applications using ML , DL methods
- To understand the Internet of Things and its benefits for society.

Course Outcomes:

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

CO1: Identify and understand the machine learning elements and techniques
CO2: Implement data preprocessing methods for IoT using python
CO3: Compare Machine Learning and Deep Learning
CO4: Identify and understand Machine Learning accelerators for IoT Devices
CO5: Design & implement deep learning model for sensor data
CO6: Compare advanced machine learning techniques
CO7::Design various IoT applications using ML and DL techniques.

Course Contents

Unit I	Overview of Machine Learning	8 Hours

Introduction to Machine Learning:

Introduction to ML, Introduction to Statistical Learning Methods, Classic and adaptive machines, Machine-Learning Problem, Machine-Learning Techniques and Paradigms, Machine Intelligence, Elements of Machine Learning, Introduction to Advanced ML - Deep Learning, Reinforcement Learning.

Unit II	Predictive Analysis for IoT	06 Hours

IOT Data Pre-processing:

Data Preparation for Predictive Maintenance Modeling, Cleaning and Standardizing IoT Data, Applying Advanced Data Exploration Techniques

Feature Engineering:

Exploring Feature Engineering, Applying Feature Selection Techniques, Feature set selection using ML, Machine learning for Internet of Things data analysis

Unit III	ML & DL Methods for IoT	06 Hours

Machine learning (ML) methods for IoT Applications :

Decision Trees (DTs), Support Vector Machines (SVMs), Bayesian theorem-based algorithms, k-Nearest neighbour (KNN), Random forest (RF), Association Rule (AR) algorithms, Ensemble learning (EL), k-Means clustering, Principal component analysis (PCA)

Deep learning (DL) methods for IoT Applications :

Convolutional neural networks (CNNs), Recurrent neural networks (RNNs), Deep autoencoders (AEs), Restricted Boltzmann machines (RBMs), Deep belief networks (DBNs), Generative adversarial networks (GANs), Ensemble of DL networks (EDLNs)

Unit IV	Machine Learning Accelerators for IoT Devices	06 Hours

Compact fast Machine Learning Accelerators for IOT devices:
Edge Computing on IOT Devices, IOT Based Smart Buildings, Distributed Machine Learning, Machine Learning Accelerator, Machine Learning Model Optimization,
Least-Squares-Solver for Shallow Neural Network: Introduction, Algorithm Optimization, Hardware Implementation

Unit V	Deep Learning for IOT	06 Hours

Deep Learning for IOT:
Deep Learning Models For Sensor Data, Embedded Deep Learning, Real Time IOT Imaging with Deep Neural Network

Unit VI	Applications of ML and IOT: Case Study Approach	06 Hours

Applications of ML and IOT :
Case Studies: IOT for Agriculture, Remote Patient Monitoring, Smart City, Smart Transportation, IOT Security using ML

Books: Text:

1. Ethem ALPAYDIN, "Introduction to Machine Learning" ,The MIT Press, October 2004, ISBN 0-262-01211-1
2. Hantao Huang, Hao Yu, "Compact and Fast Machine Learning Accelerator for IoT Devices,"Edition: 1st ed. Publisher: Springer Singapore Year: 2019ISBN: 978-981-13-3323-1

Reference:

1. Trevor Hastie Robert Tibshirani Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition, Springer Series in Statistics, Feb 2009
2. Tom M. Mitchell , " Machine Learning", McGraw-Hill Science/Engineering/Math; (March 1, 1997)ISBN: 0070428077
3. Neeraj Kumar, Aaisha Makkar, " MACHINE LEARNING IN COGNITIVE IOT", https://www.routledge.com/Machine-Learning-in-Cognitive-IoT/Kumar-Makkar/p/book/9780367359164 ISBN 9780367359164 Published June 1, 2020 by CRC Press
4. Puneet Mathur, " IoT Machine Learning Applications in Telecom, Energy, and Agriculture, With Raspberry Pi and Arduino Using Python", ISBN 978-1-4842-5549-0
5. Nicolas Modrzyk, " Real-Time IoT Imaging with Deep Neural Networks - Using Java on the Raspberry Pi 4" , Apress Publication , Year: 2020, ISBN: 9781484257210, 978148425722

Mooc Courses:

1. **Predictive Analytics for IOT, by Microsoft on edx**

Link: https://www.edx.org/course/predictive-analytics-for-iot-solutions?source=aw&awc=6798_1594277292_cca42f86ac9afe29904595a53aad9e1c

2. **INTERNET of Things and Machine Learning Training**

Link: https://shop.boltiot.com/products/internet-of-things-and-machine-learning-training

Savitribai Phule Pune University,

Pune

Honours* in Internet of Things

410602: Machine Learning for Internet of Things Laboratory

Fourth Year of Engineering (Semester VII)

Teaching Scheme:	Credit	Examination Scheme:
PR: 02 Hours/Week	01	TW: 50 Marks

Guidelines for Instructor's Manual

The instructor‘s manual is to be developed as a reference and hands-on resource. It should include prologue (about University/program/ institute/ department/foreword/ preface), University syllabus, conduction & Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software & Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. 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 must be avoided. Use of DVD 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.

Guidelines for Laboratory /TW Assessment

Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality and

Guidelines for Practical Examination

Problem statements must be decided by the internal examiner in consultation with the external examiner. During practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student‘s understanding of the fundamentals, effective and efficient implementation. The questions asked will in no way be the deciding factor for passing the students. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative

Programming tools recommended: - Data Mining Tool like WEKA , R Studio for R Programming, Anaconda for Python programming, Arduino IDE

Hardware Requirement: Various sensors as per selected application(Temperature Sensor ,

Humidity Sensor**,** for Air Quality**)** Arduino board , Raspberry Pi 3 or above Version, Py Camera	
	Suggested List of Laboratory Experiments/Assignments **(Implementation of each problem statement is mandatory.)**
Sr. No	**Group A**
1	**Programming for IOT : R- programming, Python Libraries, Azure Cloud platform** **Examining Machine Learning for IoT** Develop an Application on Arduino/Raspberry-Pi to capture the values of temperature sensor after every 15 sec of time interval, store this values in .csv format and predict the temperature at particular time t using linear regression analysis. **Hint:** Create the dataset of at least 20-25 instances, use any data analysis tool (WEKA/R)
	Getting Started with Azure Machine Learning Deploy your first Azure/Think Speak IoT Edge module to a virtual Linux or Windows device **Reference** 1. Deploy your first IoT Edge module to a Linux device 2. Deploy your first IoT Edge module to a Windows device 3. Things Speak for IoT 4. Collect the sensor data on private cloud using Things Speak
3	**Exploring Code-First Machine Learning with Python** 1. Download the Dataset of your choice 2. Divide the dataset into Training data and Testing data. 3. Perform the classification of the instances using any machine learning algorithm like KNN Algorithm, Naïve Bayes, Decision Tree or any. 4. Evaluate the machine learning model by considering the parameter (TPR, TNR, FPR, FNR, accuracy, precision, recall, error rate etc.) **References** 1. https://www.kaggle.com/datasets 2. https://archive.ics.uci.edu/ml/datasets.php

Savitribai Phule Pune University

Honours* in Internet of Things

Final Year of Engineering (Semester VIII)

410603: Internet of Things Security

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

Prerequisite Courses, if any:

- Fundamentals of Embedded Systems, IoT
- Basic of Network Security

Companion Course, if any:

Course Objectives:

- To understandIoT security issues and concerns
- To understand the main threats and attacks in IoT Environment
- To ensure user authentication
- To understand Security Requirements in IoT Architecture
- To create awareness of IoT security
- To apply Security concepts/techniques for IoT applications

Course Outcomes:

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

- CO1 -Describe IoT security issues and concerns
- CO2 -Discuss the main threats and attacks in IoT Environment
- CO3 -Verify user authentication
- CO4-Discuss Security Requirements in IoT Architecture
- CO5-Develop awareness of IoT security
- CO6-Use security concepts/techniques for IoT applications

Course Contents

Unit I	**Introduction: Securing the Internet of Things & Security Architecture**	**(07 Hours)**

Introduction, Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability , Attacks Specific to IoT

Unit II	**Security and Vulnerability in the Internet of Things**	**(08 Hours)**

Fundamentals of cryptography,Secrecy and Secret-Key Capacity, Authentication/Authorization for Smart Devices, Transport Encryption, Secure Cloud/Web Interface, Secure Software/Firmware, Physical Layer Security

Unit III	**IoT Node Authentication**	**(07 Hours)**

Security Goals in IoT, Public-Key-Based Authentication, Identify-Based Authentication, Trust models & privacy preservation, Encryption and Digital Signature, IP Connectivity, Lightweight Cryptography, Existing Security Schemes for IoT

Unit IV	**Data Protection & Security Requirements in IoT Architecture**	**(08 Hours)**

Data Protection in IoT: Data lifecycle in IoT, Protecting Data in IoT
Security Requirements in IoT Architecture: Introduction,Network Layer, Service Layer, Application-Interface Layer, Cross-Layer Threats, Threats Caused in Maintenance of IoT, cloud security for IoT, IoT Security for machine learning applications

Unit V	Security in Enabling Technologies & Existing Security Scheme for IoT	(06 Hours)

Security in Identification and Tracking Technologies, Security in Integration of Wireless Sensor Network and RFID, Security in Communications, Security Protocols and Privacy Issues into 6LoWPAN Stack, Security in Service Management, Data Security and Privacy, Data Confidentiality and Key Management Contents, Security Concerns in Social IoT, Confidentiality and Security for IoT Based Healthcare.

Unit VI	Introduction to the Use Cases and Emerging Standards and Technologies for Security and privacy in IoT	(06 Hours)

Smart Cities Overview ,The IoT and Secure Orchestration Opportunity in Cities, Security in Smart Cities, Smart Cities Example Use Cases
Connected Car Overview ,The IoT and Secure Automation Opportunity for Connected Cars, Security for Connected Cars, Connected Car Security and Automation Use Case
Blockchain technology for security and privacy in IoT, Blockchain Overview, Challenges Associated with secure IoT Deployment and Blockchain in IoT. Case Study- Smart Home, Food supply chain traceability system

Learning Resources

Text Books:

1. Orchestrating and Automating Security for the Internet of Things: Delivering Advanced Security Capabilities from Edge to Cloud for IoT, by Anthony Sabella, Rik Irons-Mclean, Marcelo Yannuzzi, Publisher: Cisco Press, Release Date: June 2018,ISBN: 9780134756936
2. Securing the Internet of Things, Shancang Li Li Da Xu, Syngress, 2017, Elsevier, ISBN: 978-0-12-804458-2
3. Internet of Things for Smart Cities Technologies, Big Data and Security,Waleed EjazAlagan Anpalagan, Springer, ISBN 978-3-319-95036-5 ISBN 978-3-319-95037-2

Reference Books:

1. Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations ", ISBN: 9781498723183, CRC Press, 2016. 6.
2. Aditya Gupta, "The IoT Hacker's Handbook: A Practical Guide to Hacking the Internet of Things", ISBN: 1484242998, Apress publisher, 2019

Online Resources:

https://nptel.ac.in/courses/106/105/106105195/

Savitribai Phule Pune University
Honours* in Internet of Things
Fourth Year of Engineering (Semester VIII)
410604: Seminar

Teaching Scheme	Credit Scheme	Examination Scheme and Marks
Practical: 02 Hours/Week	**02**	**Presentation: 50 Marks**

Course Objectives:

- To train the student to independently search, identify and study important topics in computer science.
- To develop skills among students to study and keep themselves up to date of the technological developments taking place in computer science
- To expose students to the world of research, technology and innovation.

Course Outcomes:

On completion of the course, student will be able to

- To train the student to independently search, identify and study important topics in computer science.
- To develop skills among students to study and keep themselves up to date of the technological developments taking place in computer science.
- To expose students to the world of research, technology and innovation

Guidelines for Seminar:

- The department will assign an internal guide under which students shall carry out Hons. seminar work
- In order to select a topic for Hons. Seminar, the student shall refer to various resources like books, magazines, scientific papers, journals, the Internet and experts from industries and research institutes
- The topic selected for Hons. Seminar by the students will be scrutinized and if found suitable, shall be approved by the internal guide
- Student shall submit the progress of his/her Hons. Seminar work to the internal guide.
- The student shall prepare a REPORT on the work done on Hons. Seminar and submit it at the time of presentation.

Evaluation of IT Seminar Work

- During the seminar work, its progress will be monitored, by the internal guide.
- At the end of seminar work, copy of Hons. Seminar Report should be prepared and submitted to department.
- End Examination shall be based on the Report, Presentation.
- Guidelines for Assessment: Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

References:

1. Rebecca Stott, Cordelia Bryan, Tory Young, “Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series)”, Longman, ISBN-13: 978-0582382435
2. Johnson-Sheehan, Richard, “Technical Communication”, Longman. ISBN 0-321-11764-6
3. Vikas Shirodka, “Fundamental skills for building Professionals”, SPD, ISBN 978-93-5213- 146-5