Savitribai Phule Pune University
Fourth Year of Artificial Intelligence and Data Science (2020 Course)
Elective III 417523(B): Industrial Internet of Things

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisites Courses: Internet of Things (217529), Cloud Computing (310254(C)), Cyber Security (317530)

Companion Course: Computer Laboratory II (417526)

Course Objectives:

- To understand the concepts of Industrial IOT Systems and its relevance in industrial applications
- To discuss and study the implementation system of IIOT
- To identify IIOT components required for IIOT architecture
- To analyze the cloud computing in context of IIOT
- To scrutinize security challenges and solutions in IIOT system
- Use of IIOT in various applications and provide an understanding of use cases of IIOT beneficial for society

Course Outcomes:

After completion of the course, learners should be able to-

CO1: Understand the basic knowledge of Industrial IOT, its challenges, benefits and significance in industrial applications

CO2: Illustrate the use of sensors, actuators and communication protocols used in implementation of IIOT

CO3: Elaborate the IIOT components required for IIOT architecture

CO4: Analyze the role of cloud computing in IIOT including data storage, processing and data analytics and Digital Twin

CO5: Recognize the importance of security in IIOT and solutions to mitigate security risks

CO6: Categorize the various IIOT applications and use cases of IIoT implemented in various industries

Course Contents

Unit I	Introduction to Industrial Internet of Things (IIoT)	07 Hours

Introduction to IIOT, History of IIOT, IOT Vs. IIOT, The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Smart Factories, Role of IIOT in Manufacturing Processes, Use of IIOT in plant maintenance practices, Sustainability through Business excellence tools Challenges, Benefits in implementing IIOT, Applications of IIOT

#Exemplar/Case Studies	The Internet of Things (IoT) is penetrating almost all sectors of the global economy, addressing a wide range of opportunities
***Mapping of Course Outcomes for Unit I**	CO1

Unit II	IIoT System Protocols	07 Hours

Sensors and Actuators used for Industrial Processes, Roles of sensors and actuators in IIOT, IIOT Sensor networks, Process automation and Data Acquisitions on IIoT Platform, Communication and Networking of IIoT-Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI , I2C, The field bus, Industrial automation: PLC and SCADA ICS Protocol: Ethernet IP, Modbus TCP/IP, ProfiNet, DNP3, EtherCAT, CCLink IE and OPC UA	
#Exemplar/Case Studies	Building an Industrial IoT Infrastructure with open Source Software for Smart Energy
***Mapping of Course Outcomes for Unit II**	CO2
Unit III	**IIoT Architecture** **07 Hours**
Overview of IIOT components including Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT, Architecture of Industrial IoT: Business Model and Reference Architecture, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication. IIoT Networking	
#Exemplar/Case Studies	Airbus uses Bosch's IIoT platform to build a smart factory
***Mapping of Course Outcomes for Unit III**	CO3
Unit IV	**Cloud and Data Analytics for IIoT** **07 Hours**
IIoT cloud platforms: Overview of Cloud of Things (COT) cloud platforms, Predix, PTC Thing Worx, Microsoft Azure, cloud services, Business models: SaaS, PaaS, IaaS. Data Analytics for IIOT: IoT Analytics, Role of Analytics in IIoT & Data visualization Techniques. DIGITAL TWIN for IIOT: Introduction to Digital Twin, need for Digital Twin, Elements of Digital Twin, Digital Twin process design and information requirements	
#Exemplar/Case Studies	Building a Hybrid Edge Cloud IIoT Platform
***Mapping of Course Outcomes for Unit IV**	CO4
Unit V	**IIoT Security Challenges and Solutions** **07 Hours**
Introduction: Importance of Security for Industrial IOT, Conventional web technology and relationship with IIoT, Vulnerabilities of IIoT, Privacy, Security requirements. Components of IIOT Security-Threat analysis, identity establishment, access control, message integrity, Non-repudiation and availability. Security model for IoT, Trust–Trust and Trust Models for the IoT, IoT security tomography and layered attacker model, Network security techniques Management aspects of cyber security.	
#Exemplar/Case Studies	An Edge Decentralized Security Architecture for Industrial IoT Applications
***Mapping of Course Outcomes for Unit V**	CO5
Unit VI	**Applications, Use cases and Industry Revolution** **07 Hours**

Applications: - Smart Robotics, Smart Metering, Smart Irrigation, Smart Manufacturing (Lean manufacturing). Use Cases: - Healthcare, Smart Office, Smart Logistics, IOT Innovations in Retail, Cyber Manufacturing Systems. Industry 4.0: - Introduction, Definition, Why Industry 4.0 and Why Now? Characteristics, Design Principles, Advantages and applications of Industry 4.0, Introduction to Industry 5.0 (Society 5.0).	
#Exemplar/Case Studies	Case Study: Robotics Integrator Discovers Binder Jet 3D Printing for Automotive End-of-Arm Tooling
***Mapping of Course Outcomes for Unit VI**	CO6

Learning Resources

Text Books:

1. Industrial Internet of Things Technologies and Research Directions, Anand Sharma, Sunil Kumar Jangir, Manish Kumar, Dilip Kumar Choubey, Tarun Shrivastava, S. Balamurugan, CRC press
2. Veneri, Giacomo, and Antonio Capasso- Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0, 1stEd., Packt Publishing Ltd, 2018
3. Industry 4.0: The Industrial Internet of Things Alasdair GilchristPublications: Apress

Reference Books:

1. Alasdair Gilchrist- Industry 4.0: The Industrial Internet of Things, 1st Ed., Apress, 2017. 2. Reis, Catarina I., and Marisa da Silva Maximiano, eds.- Internet of Things and advanced application in Healthcare, 1st Ed., IGI Global, 2016
2. S. Misra, C. Roy, and A. Mukherjee, 2020. Introduction to Industrial Internet of Things and Industry 4.0. CRC Press
3. Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance, R. Anandan, Suseendran Gopalakrishnan, Souvik Pal, Noor Zaman, Wiley publication

e-Resources:

1. How Protocol Conversion Addresses IIoT Challenges: White Paper ByRed Lion
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SECA4005.pdf
3. https://www.ge.com/digital/applications/digital-twin
4. https://www2.deloitte.com/us/en/insights/focus/industry-4-0/digital-twin-technology-smart-factory.html

MOOC Courses:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. https://www.coursera.org/specializations/developing-industrial-iot#courses
3. https://www.coursera.org/learn/industrial-internet-of-things
4. https://www.coursera.org/learn/internet-of-things-sensing-actuation

The CO-PO Mapping Matrix

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	-	-	-	-	-	-	-	-	-
CO2	1	2	2	2	-	-	-	-	-	-	-	2
CO3	2	1	2	-	-	-	-	-	-	-	-	2
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	2	2	2	-	-	-	-	-	-	-	2
CO6	2	2	2	2	-	-	2	-	-	-	-	2