VIVEKANAND EDUCATION SOCIETY'S
Institute of Technology
(An Autonomous Institute Affiliated to University of Mumbai, Approved by A.I.C.T.E & Recognized by Govt. of Maharashtra)
Department of Artificial Intelligence and Data Science

Department of

Artificial Intelligence and Data science Syllabus (NEP Scheme)

Dual Multidisciplinary Minor

Internet of Things(IoT)

w.e.f. A.Y. 2025-26

Dual Multidisciplinary Minor
Internet of Things(IoT)

Teaching Scheme

Course Type	Semester	Course Name	Teaching scheme (Contact Hours)			Credits Assigned			
			Th	Pr	Tut	Th	Pr	Tut	Total
MDM- I	V	IoT Sensor System	3	2		3	1		4
MDM- II	VI	IoT architecture and protocols	3	2+2*		3	2		5
MDM- III	VII	Dynamic paradigms in IoT	3	2+2*		3	2		5
MDM- IV	VIII	NPTEL COURSE : Cyber physical system	4			4			4
Total Credits						13	5		18
* Self study : Mini Project slot									

Examination Scheme

Course Type	Semester	Course Name	Marks Scheme					
			Th	MT	CA	TW	Pr/Or	Total
MDM- I	V	IoT Sensor System	60	20	20	25		125
MDM- II	VI	IoT architecture and protocols	60	20	20	25	25	150
MDM- III	VII	Dynamic paradigms in IoT	60	20	20	50		150
MDM- IV	VIII	NPTEL COURSE : Cyber physical system	60	20	20			100
Total Marks								425

SEM- V MDM-I
COURSE NAME: IoT SENSOR SYSTEMS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-I	IoT Sensor Systems (Theory)	03	---	---	03	---	---	03
MDM-I	IoT Sensor Systems (Lab)	---	02	---	---	01	---	01

IoT Sensor Systems(Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-I	IoT Sensor Systems (Theory)	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-I	IoT Sensor Systems (Theory)	20	20	60	02			100

Prerequisite: Engineering basics of Measurement	
Course Objectives:	
1.	To introduce the fundamentals of sensors, transducers, and their role in IoT applications.
2.	To explain the working principles and applications of temperature, strain, force, torque, and pressure sensors.

3.	To study velocity, acceleration, position, and displacement sensors used in measurement systems.
4.	To explore wireless sensor technologies and their significance in industrial and IoT networks.
5.	To provide knowledge of sensor interfacing techniques with microcontrollers.
6.	To enable students to develop basic sensor-based applications using Arduino for IoT systems.
Course Outcomes: On successful completion of course, learner/student will be able to:	
1	Classify *types and applications of temperature sensors and transducers used in IoT.*
2	Describe different strain, force, torque, and pressure sensors used in measurement systems.
3	Analyze the working principles of velocity and acceleration sensors.
4	Describe various position, direction, and displacement sensors used in IoT.
5	Summarize wireless sensor technologies used in industrial and IoT applications.
6	Develop Arduino-based applications for sensor interfacing with microcontrollers.

Module	Content	Hrs
1	**Introduction of Sensors & Temperature Sensors** Introduction of IoT, Definition of Sensor & Transducers, Need for sensors and Transducers in IoT, Sensor Classification, Static and Dynamic characteristics of transducers Need of Temperature Measurement, Resistance Temperature Detector (RTD), Principle, types, configurations, construction and working of RTD, self heating effect, Thermistor, NTC & PTC Types, applications Thermocouple: Principle, thermo electric effect, See-beck effect, Peltier effect, types of thermocouples with characteristic curve, Sensitivity, cold junction compensation method Pyrometers: Principle, construction and working of radiation and optical Pyrometers and its applications	8

2	**Strain, Force, Torque and Pressure sensors** Introduction types of strain gauges, gauge factor calculation, materials for strain gauge, resistance strain gauge bridges, temperature compensation and applications of strain gauges Force measurement using strain gauge, LVDT, piezoelectric sensors Torque measurement using Torsion bar, strain gauges. Pressure scales, units and relations, elastic pressure sensors like bourdon tube, diaphragm, bellows, Secondary Pressure Transducers like capacitive, piezo-electric, LVDT, strain gauge	9
3	**Velocity and Acceleration sensors** Electromagnetic velocity sensor, Doppler with sound, light Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes.	5
4	**Position, Direction, Displacement Sensors** Potentiometric and capacitive sensors, Inductive and magnetic sensor LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magnetostrictive sensors	5
5	**Wireless Sensors** Wireless Data and Communications, Wireless Sensing Networks, Industrial Wireless Sensing Networks RF Sensing, Telemetry, RF MEMS.	5
6	**Interfacing of Sensors to Microcontroller** Basic introduction of microcontroller, need of microcontroller in IoT Introduction to Arduino Board, Setup the IDE, Writing Arduino Software, Arduino Libraries for sensors.	7

Reference Books	
1	John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida.
2	A. K.Sawheny, "A course in Electrical and Electronic Measurements and Instrumentation"

Term work
Total 25 Marks Term work will be based on overall performance in the subject to be assessed via Tutorials/Assignment/Viva/ Mini Project based on application of the syllabus.

Internal Assessment
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No.	Rubrics	Marks
1	*Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Content beyond syllabus presentation	10 marks
3	Creating Proof of concept	10 marks
4	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5	Multiple Choice Questions (Quiz)	5 marks
6	GATE Based Assignment/Tutorials etc	10 marks

*For sr. no. 1, the date of the certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

End Semester Theory Examination	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five need to be solved.

IoT Sensor Systems (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-I	IoT Sensor Systems (Lab)	-	02	-	-	01	-	01

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-I	IoT Sensor Systems (Lab)	-	-	-	-	25		25

Prerequisite: Engineering basics of Measurement

Lab Objectives:

1.	To introduce students to the basics of Arduino microcontroller and sensor interfacing.
2.	To provide hands-on experience in interfacing various sensors (temperature, humidity, distance, pressure, etc.) with Arduino.
3.	To enable students to acquire real-time sensor data and perform basic data processing using Arduino.
4.	To develop skills in displaying sensor data on external devices like LCDs and through wireless communication (RF/Bluetooth).
5.	To design and implement IoT-based systems that monitor and transmit sensor data in real-time.
6.	To teach troubleshooting and debugging techniques for Arduino circuits and sensor interfaces.

Lab Outcomes: On successful completion of course, learner/student will be able to:

1	**Understand** the basic working principles and components of the Arduino microcontroller and associated sensors.
2	**Interface** different types of sensors (temperature, humidity, distance, pressure, etc.) with the Arduino and **acquire** real-time sensor data.
3	**Analyze** the sensor outputs and **calibrate** them for accurate measurement in real-world applications.

4	**Design** and **develop** Arduino-based systems to collect and display sensor data on devices such as LCDs or through wireless communication (RF/Bluetooth).
5	**Implement** IoT systems that utilize sensors for real-time data monitoring and wireless transmission to other devices or networks.
6	**Troubleshoot** and **debug** Arduino circuits and sensor interfaces to ensure correct sensor data collection and processing.

Suggested List of Experiments	
Sr. No.	**Title of Experiments**
1.	Introduction to Arduino Microcontroller and Arduino IDE
2.	Interfacing Humidity Sensor (DHT11) with Arduino
3.	Interfacing Ultrasonic Sensor (HC-SR04) with Arduino for Distance Measurement
4.	Interfacing Gas Sensor (MQ-2/MQ-135) with Arduino
5.	Temperature Measurement using LM35 Sensor and Arduino
6.	Interfacing Accelerometer Sensor (ADXL335/ADXL345) with Arduino
7.	Interfacing Pressure Sensor (BMP180 or MPX5010) with Arduino
8.	Interfacing LDR (Light Dependent Resistor) for Light Intensity Detection
9.	Wireless Transmission of Sensor Data using RF or Bluetooth Module (HC-05)
10.	Display Sensor Data on 16x2 LCD using Arduino
11.	Interfacing Soil Moisture Sensor with Arduino
12.	Interfacing PIR Motion Sensor with Arduino

SEM- VI MDM-II

COURSE NAME: IoT Architecture and Protocols

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-II	IoT Architecture and Protocols (Theory)	03	---	---	03	---	---	03
MDM-II	IoT Architecture and Protocols (Lab)	---	02+02*	---	---	02	---	02

IoT Architecture and Protocols(Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-II	IoT Architecture and Protocols (Theory)	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-II	IoT Architecture and Protocols(Theory)	20	20	60	02			100

Prerequisite: Python programming ,C programing language, Computer Networks	
Course Objectives:	
1.	To understand IoT Characteristics and Conceptual Framework
2.	To comprehend network architecture and design of IoT
3.	To understand smart objects in IoT
4.	To correlate the connection of smart objects and IoT access technologies
5.	To explore network layer and application layer protocols for IoT
6.	To explore IoT security aspect
Course Outcomes: On successful completion of course, learner/student will be able to:	
1	Describe the IoT Characteristics and Conceptual Framework
2	Differentiate between the levels of the IoT architectures
3	Interpret sensor network and its components
4	Analyze the IoT access technologies
5	Illustrate various protocols at network layer and application layer for IoT
6	Analyze and evaluate security issues in IoT and risk analysis structure

Module	Content	Hrs.
0	**Prerequisite** Ports, Timers ,Programming of controller , How to use IDE to write code of microcontroller, TCP-IP protocol stack	2
1	**Introduction to IoT:** Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Basics of networking Communication protocol, wireless sensor networks. **Convergence of IT and OT** -IoT Challenges, IoT protocol vs Web Protocol stack **Self-learning Topics:** Hardware and software development tools for - *A*rduino,	6

	NodeMCU, ESP32, Raspberry Pi pico	
2	**IoT Network Architecture and Design** **Drivers Behind New Network Architectures**: Scale,Security,Constrained Devices and Networks ,Data,Legacy Device Support **Architecture :** The IoT World Forum (IoTWF) Standardized Architecture :Layer 1-7, IT and OT Responsibilities in the IoT Reference Model, Additional IoT Reference Models, A Simplified IoT Architecture, The Core IoT Functional Stack ::Layer 1-3 , Analytics Versus Control Applications , Data Versus Network Analytics Data Analytics Versus Business Benefits , Smart Services, **IoT Data Management and Compute Stack** :Fog Computing , Edge Computing ,The Hierarchy of Edge, Fog, and Cloud	7
3	**Smart Objects IoT** **Sensors, Actuators, and Smart Objects , Sensors , Actuators** **Micro-Electro-Mechanical Systems (MEMS)** Smart Objects: A Definition , Trends in Smart Objects, **Sensor Networks** , Wireless Sensor Networks (WSNs) , Communication Protocols for WSN,RFID ,NFC **Self-learning Topics:** RFID in Libraries	5
4	**Connecting Smart Objects** **Communications Criteria** : Range , Frequency Bands , Power Consumption , Topology , Constrained Devices , Constrained-Node Networks , Data Rate and Throughput , Latency and Determinism , Overhead and Payload , **IoT Access Technologies** : Standardization and Alliances , Physical Layer , MAC Layer , Topology ,Security and Conclusion of IEEE 802.15.4 , IEEE 802.15.4g and 802.15.4e ,IEEE 1901.2a ,IEEE 802.11ah , LoRaWAN, and NB-IoT and Other LTE Variations , LTE Cat 0 , LTE-M, NB-IoT **Self-learning Topics:** case studies	5
5	**IoT Network Layer and Application protocols** The Business Case for IP , The Key Advantages of Internet Protocol ,Adoption or Adaptation of the Internet Protocol ,The Need for Optimization ,Constrained Nodes , Constrained Networks IP Versions , Optimizing IP for IoT , From 6LoWPAN to 6Lo, Header Compression, Fragmentation , Mesh Addressing ,Mesh-Under Versus Mesh-Over Routing , 6Lo Working Group , 6TiSCH , RPL , Objective Function Rank, RPL Headers ,Metrics , Authentication and Encryption on Constrained Nodes , ACE , DICE, Profiles and Compliances, Internet Protocol for Smart Objects Alliance ,Wi-SUN	7

	Alliance, Thread, IPv6 Ready Logo The Transport Layer , IoT Application Transport Methods,Generic Web-Based Protocols , IoT Application Layer Protocols , CoAP, MQTT, AMQP **Self-learning Topics:** case studies	
6	**Securing IoT** **A Brief History of OT Security** Common Challenges in OT Security : Erosion of Network Architecture,Pervasive Legacy Systems,Insecure Operational Protocols like Modbus, DNP3 ,ICCP ,OPC , (IEC) Protocols,Device Insecurity **Security Knowledge:** IT and OT Security Practices and Systems Vary, The Purdue Model for Control Hierarchy, OT Network Characteristics Impacting Security, Security Priorities: CIA, Security Focus **Formal Risk Analysis Structures**: OCTAVE and FAIR, FAIRThe Phased Application of Security in an Operational Environment , Secured Network Infrastructure and Assets, Deploying Dedicated Security Appliances, Higher-Order Policy Convergence and Network Monitoring **Self-learning Topics:** OWASP IoT Top 10 attacks ,X.509, SSL & TSL basics	7
	TOTAL	39

Text Books	
1	Arsheep Bahga (Author), Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020
2	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.

Reference Books	
1.	Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRC press,
2.	Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3.	Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4.	Amita Kapoor, "Hands on Artificial intelligence for IoT", 1st Edition, Packt Publishing, 2019.

5.	Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT)Ecosystem:Insight Paradigm, Springer

Online References:

1. https://owasp.org/www-project-internet-of-things/
2. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
3. NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Term work

Total 25 Marks Term work will be based on overall performance in the subject to be assessed via Tutorials/Assignment/Viva/ Mini Project based on application of the syllabus.

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No.	Rubrics	Marks
1	*Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Content beyond syllabus presentation	10 marks
3	Creating Proof of concept	10 marks
4	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5	Multiple Choice Questions (Quiz)	5 marks
6	GATE Based Assignment/Tutorials etc	10 marks

*For sr. no. 1, the date of the certification exam should be within the term and in case a student is

unable to complete the certification, the grading has to be done accordingly.

End Semester Theory Examination	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five need to be solved.

IoT Architecture and Protocols (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-II	IoT Architecture and Protocols (Lab)	-	02+02*	-	-	02	-	02

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-II	IoT Architecture and Protocols (Lab)	-	-	-	-	25	25	50

Prerequisite: Engineering basics of Measurement	
Lab Objectives:	
1	To understand the hardware and software components of IoT systems, including microcontrollers, sensors, and communication protocols.
2	To design and implement IoT applications using microcontrollers such as NodeMCU and ESP32 with various sensors and communication interfaces.
3	To explore web-based and lightweight communication protocols such as HTTP, MQTT, and CoAP used in IoT.
4	To simulate and analyze IoT network protocols such as RPL and 6LoWPAN using Cooja simulator.
5	To connect IoT devices to cloud platforms using webhooks and IFTTT for data logging and automation.
6	To evaluate IoT system performance and security aspects, including edge vs cloud computing and packet-level data analysis.
Lab Outcomes: On successful completion of course, learner/student will be able to:	

1	Students will be able to interface sensors and actuators with IoT hardware using GPIOs and timers.
2	Students will be able to create basic web servers and dashboards using NodeMCU/ESP32 to visualize IoT data.
3	Students will implement MQTT and CoAP communication protocols to establish device-to-device and RESTful communications.
4	Students will use Cooja simulator to model and analyze low-power IoT networks and protocol stacks.
5	Students will integrate IoT devices with cloud platforms using APIs and services like IFTTT.
6	Students will assess IoT system behavior in terms of latency, routing, and security through packet analysis and architecture simulations.

Sr. No.	**Suggested List of Experiments**
1	Blinking LED with Timers and GPIO using NodeMCU/ESP32
2	Creating a Web Server on NodeMCU/ESP32 to Display Dummy Sensor Data
3	MQTT-based Communication Between Two Devices
4	LoRa Peer-to-Peer Communication for IoT Data Exchange
5	Cooja Simulation: RPL Protocol Implementation
6	Cooja Simulation: 6LoWPAN Packet Transmission and Fragmentation
7	Implementing CoAP Client and Server using Python
8	Wi-Fi Signal Strength Logger with ESP32
9	Cloud Logging with Google Sheets using IFTTT/Webhooks
10	IoT Security: Sniffing and Analyzing MQTT/HTTP Packets using Wireshark
11	Edge vs Cloud Processing Latency Comparison
12	Simulating 3-Layer IoT Architecture (Device–Edge–Cloud)

Students are supposed to complete one mini project on above syllabus

SEM- VII MDM-III
COURSE NAME:Dynamic Paradigm in IoT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-III	Dynamic Paradigm in IoT(Theory)	03	---	---	03	---	---	03
MDM-III	Dynamic Paradigm in IoT (Lab)	---	02+02*	---	---	02	---	02

Dynamic Paradigm in IoT(Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-III	Dynamic Paradigm in IoT(Theory)	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-III	Dynamic Paradigm in IoT(Theory)	20	20	60	02			100

Course Objectives:	
1.	To explore the role of the cloud in Internet of Things deployment.
2.	To introduce the usage of different machine learning algorithms on IoT Data
3.	To explore data analytics and data visualization on IoT Data

4.	To explore the role of Fog computing in Internet of Things
5.	To explore design issues and working principles of various security measures and various standards for secure communication in IoT
6.	To develop the ability to integrate IoT with Dev-ops.

Course Outcomes: Learner will be able to	
1.	Identify the need for the cloud in IoT deployment and describe different Cloud provider's architecture.
2.	Use and correlate machine learning techniques on IoT Data.
3.	Apply IoT analytics and data visualization
4.	Recognize the use of Fog Computing in the Internet of things
5.	Explain the need for security measures in the Internet of Things.
6.	Apply the knowledge of Dev-ops in IoT applications

Sr. No.	**Detailed Content**	**Hours**
0	**Prerequisite** Basics of Cloud Computing, Basics of Machine learning and primitives of cryptography	--
1	**IoT and Cloud** Cloud Computing Concept, Grid/SOA and Cloud Computing, Cloud Middleware NIST's SPI Architecture and Cloud Standards, The Cloud of Things--The Internet of Things and Cloud Computing The Cloud of Things Architecture-- Four Deployment Models, Vertical Applications, Fifteen Essential Features, Four Technological Pillars, Three Layers of IoT Systems, Foundational Technological Enabler Cloud Providers and Systems -- Microsoft Azure IoT, Amazon Web Services, Google's cloud IoTs.	**6**

	Self-learning Module: IBM Watson Cloud	
2	**IoT and Machine Learning** Advantages of IoT and Machine Learning Integration, Implementation of Supervised Algorithm- Regression (Linear and Logistic), SVM, Decision Tree and Nave Bayes, Deep learning for IoT-Neural Network on case study: Agriculture and IoT, Smart Home etc. **Self-Learning Module:** Regression, SVM, Decision Tree, Navy Bayes and Deep learning.	**4**
3	**IoT and Data Analytics** Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud-Microsoft Azure overview– Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets, Managing Data lakes, The data retention strategy. Communicating with Others- Visualization and Dash boarding- Designing visual analysis for IoT data, creating a dashboard – creating and visualizing alerts.	**6**
4	**IoT and Fog Computing** Fog computing Basics, The Hadoop philosophy for Fog computing, Fog Computing versus Edge Computing versus cloud computing, Open Fog Reference Architecture Application services-- Application support, Node management and software backplane, Hardware virtualization, Open Fog node security, Network Accelerators Compute, Storage Hardware platform infrastructure, Protocol abstraction, Sensors, actuators, and control systems, Fog Topology. **Self-learning Module: Amazon Green grass and Lambda (implementation)**	**6**
5	**IoT and it's Security** Cyber security vernacular Attack and threat terms, Defense terms, Anatomy of IoT cyber attacks – Mirai, Stuxnet, Chain Reaction, Physical and hardware security, Root of Trust, Key management and trusted platform modules, Processor and memory space, Storage security, Network stack – Transport Layer Security, Software defined perimeter, Software-Defined Perimeter architecture, Blockchains and cryptocurrencies in IoT, Bitcoin (blockchain-based), IOTA: distributed ledger (directed a cyclical graph-based) , Government regulations and intervention, US Congressional Bill –Internet of Things (IoT) Cybersecurity Improvement Act	**8**

	of 2017, Other governmental bodies, IoT security best practices, Holistic security, OWASP-Existing Security attacks and its prevention methods.	
6	**IoT and Devops** **Introduction to DevOps, DevOps application - business scenarios, DevOps process** -- Source Code Management (SCM), Code review, Configuration Management, Build management, Artifacts repository management, Release management, Test automation, Continuous integration, Continuous delivery, Continuous deployment, Infrastructure as Code, Routine automation, Key application performance monitoring/indicators. **DevOps frameworks--**DevOps maturity life cycle, DevOps maturity map, DevOps progression framework/readiness model, DevOps maturity checklists, Agile framework for DevOps process projects, Agile ways of development **Tool for IoT—**Chef and Puppet, Setting up Chef and Puppet, Multi-tier Application Deployment, NETCONF-YANG Case Studies- Steps for IoT device management with NETCONF-YANG, Managing Smart irrigation IoT system with NETCONF-YANG, Managing Home Intrusion Detection IoT system with NETCONF-YANG	**6**
	TOTAL	**39**

Text Books:

1. The Internet of Things in the Cloud A Middleware Perspective, Honbo Zhou – CRC Publication.
2. Analytics for the Internet of Things (IoT), Andrew Minteer, Packt Publication 2017
3. Internet of Things- Hands on Approach, Arshdeep Bagha, Vijay Medisetti, Published by Arshdeep Bagha and Vijay Medisetti,2014.
4. Hands-on DevOps, Sricharan Vadapalli, Packt Publication, 2017
5. Internet of things For Architects, Perry Lea Packt Publication,2018

References:

1.	Enterprise Cloud Computing, Gautam Shroff, Cambridge,2010
2.	Mastering Cloud Computing -Foundations and Applications Programming, Raj Kumar Buyya, Christian Vecchiola, S. Thamarai Selvi, MK Publication, 2013.
3.	Machine Learning in Action‖, Peter Harrington, DreamTech Press
4.	Introduction to Machine Learning‖, Ethem Alpaydın, MIT Press
5.	Learning AWS IoT- Effectively Manage Connected Devices on the AWS Cloud Using Services Such as AWS Greengrass, AWS Button, Predictive Analytics and Machine Learning, Agus Kurniawan, Packt Publication,2018
6.	Practical Dev-Ops, Joakim Verona, Packt Publication, 2016

Online References:

1. **25 datasets for Deep Learning IoT-** https://hub.packtpub.com/25-datasets-deep-learning-iot/
2. https://data.world/datasets/iot
3. https://dashboard.healthit.gov/datadashboard/data.php
4. https://www.data.gov/
5. https://dev.socrata.com/data/
6. https://www.kaggle.com

Dynamic Paradigm in IoT (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-III	Dynamic Paradigm in IoT (Lab)	-	02+02*	-	-	02	-	02

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-III	Dynamic Paradigm in IoT (Lab)	-	-	-	-	50		50

Prerequisite:	
Lab Objectives:	
1	Understand the integration of IoT devices with various cloud platforms such as Microsoft Azure, AWS, and Google Cloud for real-time data ingestion and processing.
2	Implement machine learning models (e.g., Decision Tree, Regression) for predictive analytics on IoT-generated data using cloud-based or local tools.
3	Explore fog and edge computing concepts by simulating data filtering and processing at local nodes before cloud transmission.
4	Design secure communication channels for IoT devices using protocols such as MQTT over TLS and analyze vulnerabilities through controlled attack simulations.
5	Visualize IoT data using dashboards and alert systems on platforms like Power BI and ThingSpeak for decision-making and monitoring.
6	Apply DevOps practices for IoT systems, automating configuration, deployment, and remote

	management using tools like Chef, Puppet, and NETCONF-YANG.
Lab Outcomes: On successful completion of course, learner/student will be able to:	
1	Connect IoT devices to cloud platforms and manage real-time data communication effectively.
2	Analyze IoT data using machine learning models and extract meaningful insights from structured datasets.
3	Simulate fog and edge processing architectures using tools like Node-RED and Raspberry Pi.
4	Evaluate security threats in IoT environments and implement secure communication practices using TLS and Wireshark.
5	Design dashboards for IoT analytics and configure alert mechanisms for smart monitoring systems.
6	Automate IoT device management using DevOps tools, enabling scalable and maintainable deployments.

Suggested List of Experiments	
Sr. No.	**Title of Experiments**
1.	Deploying a Virtual IoT Device on Microsoft Azure IoT Hub.
2.	Collecting IoT Sensor Data and Storing in AWS DynamoDB via AWS IoT Core.
3.	Google Cloud IoT Core: Device Registration and Data Ingestion.
4.	IoT Data Analysis using Azure Machine Learning Studio (Regression or Classification).
5.	Implementing a Decision Tree Model for Smart Home Data using Python.
6.	Creating a Fog Node Simulation using Node-RED and Raspberry Pi.

7.	Real-time IoT Dashboard using ThingSpeak or Power BI with Live Sensor Feed.
8.	Designing and Analyzing a Secure MQTT Communication using TLS.
9.	Simulating IoT Cyberattack (e.g., Mirai Botnet Behavior) in a Controlled Network Lab (Cooja).
10.	Deploying a Lambda Function in AWS Greengrass to Process Sensor Input.
11.	Automated Smart Irrigation Control using NETCONF-YANG Protocol Simulation (Cooja).
12.	Setting up Chef/Puppet for Remote IoT Device Configuration and Deployment.

Students are supposed to complete one mini project on above syllabus

SEM- VIII MDM-IV
NPTEL COURSE: Cyber Physical System

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-IV	Cyber Physical System	04	---	---	04	---	---	04

Dynamic Paradigm in IoT(Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
MDM-IV	Cyber Physical System	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
MDM-IV	Cyber Physical System	20	20	60	02			100

PRE-REQUISITES : 1. Basic Programming Knowledge 2. Engineering Mathematics

COURSE OUTLINE : Cyber-physical systems (CPS), which consist of physical systems tightly integrated and/or controlled by software, are ubiquitous in many safety critical domains, including automotive, avionics, railways, healthcare, atomic energy, power, and industrial automation. The principles of design and implementation of cyber-physical systems are remarkably different from that of other embedded systems because of the tight integration of real valued and dense time real time systems with software based discrete automated control. The objective of this course is to develop an

exposition of the challenges in implementing a cyber-physical system from a computational perspective, but based equally on the principles of automated control. The course aims to expose the student to real world problems in this domain and provide a walk through the design and validation problems for such systems. With the advent of Al techniques, their increased use in CPS is also a promising growth vertical along with the necessity of safety assurance. In this course we also touch upon concepts of Neural Network based decision making for Continuous Systems while guaranteeing safety and stability using control theoretic constraint solving.

Module	Content	Hrs
1	CPS : Motivational examples and compute platforms, Real time sensing and communication for CPS	8
2	Real time task scheduling for CPS, Dynamical system modeling, stability, controller design	10
3	Delay-aware Design; Platform effect on Stability/Performance, Hybrid Automata based modeling of CPS	8
4	Reachability analysis, Lyapunov Stability, Barrier Functions	8
5	Quadratic Program based safe Controller Design, Neural Network (NN) Based controllers in CPS	8
6	State Estimation using Kalman Filters (KF) Week 12: Attack Detection and Mitigation in CPS	10
	TOTAL	52

NPTEL link ::: https://archive.nptel.ac.in/courses/106/105/106105241/