

NUTAN MAHARASHTRA VIDYA PRASARAK MANDAL'S

**NUTAN MAHARASHTRA INSTITUTE OF ENGINEERING
AND TECHNOLOGY**

AN AUTONOMOUS INSTITUTE | UNDER ADMINISTRATIVE SUPPORT OF PCET



**Curriculum Structure and Syllabus
of
M. Tech. Electronics and Telecommunication
Engineering
IoT and Sensor Systems (2026 Pattern)**



VISION OF THE INSTITUTE

To be a notable institution for providing quality technical education and ensuring ethical, moral and holistic development of students.

MISSION OF THE INSTITUTE

To nurture engineering graduates with state of the art competence, professionalism and problem solving skills to serve needs of industry as well as society.

VISION OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

To be a renowned department of Electronics and Telecommunication engineering for providing quality technical education through holistic development of the students.

MISSION OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

- To impart quality technical education for students with continuous upgraded teaching learning process.
- To enhance the employability and entrepreneurship through Industry Institute association.
- To enhance the research competency in students by adapting state of art technology in Electronics and Communication Engineering.
- To inculcate the needs of profession for the society.

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SEMESTER WISE COURSE DISTRIBUTION

COURSE DISTRIBUTION: SEMESTER WISE						
1 Lecture hour = 1 Credit, 2 Lab Hours = 1 Credit, 1 Tutorial Hour = 1 Credit						
Sl. No.	TYPE OF COURSE	NO OF COURSE / SEMESTER				Total
		1	2	3	4	
1.	Programme Core Course (PCC)	3	4	-	-	7
2.	Programme Elective Course (PEC)	3	1	-	-	4
3.	Open Elective Course (OEC)	-	1	-	-	1
4.	Experiential Learning Course(Research Methodology)	1	1	1	1	4
5.	Experiential Learning (ELC) (OJT/Internship)	-	-	1	-	1
6.	Experiential Learning Course(Research Project)	-	-	1	1	2
7.	Self Learning Course (SLC)	-	-	1	-	1
Total		7	7	4	2	20

COURSE-WISE CREDIT DISTRIBUTION

Sl. No.	Type of Course	No. of Courses	Total Credits	
			No.	%
1.	Programme Core Course (PCC)	7	24	27
2.	Programme Elective Course (PEC)	4	11	13
3.	Open Elective Course (OEC)	1	3	3
4.	Experiential Learning Course(Research Methodology)	4	14	16
5.	Experiential Learning (ELC) (OJT/Internship)	1	5	5
6.	Experiential Learning Course(Research Project)	2	27	31
7.	Self Learning Course (SLC)	1	4	5
TOTAL		20	88	100

SEMESTER-WISE CREDIT DISTRIBUTION

CREDIT DISTRIBUTION: SEMESTER WISE						
1 Lecture hour = 1 Credit, 2 Lab Hours = 1 Credit, 1 Tutorial Hour = 1 Credit						
Sl. No.	TYPE OF COURSE	NO OF CREDIT / SEMESTER				Total
		1	2	3	4	
1.	Programme Core Course (PCC)	10	14	-	-	24
2.	Programme Elective Course (PEC)	8	3	-	-	11
3.	Open Elective Course (OEC)	-	3	-	-	3
4.	Experiential Learning Course(Research Methodology)	4	2	4	4	14
5.	Experiential Learning (ELC) (OJT/Internship)	-	-	5	-	5
6.	Experiential Learning Course(Research Project)	-	-	9	18	27
7.	Self Learning Course (SLC)	-	-	4	-	4
Total		22	22	22	22	88

CURRICULUM STRUCTURE
First Year M. Tech. E and TC Engineering
(IoT and Sensor Systems)
Semester – I

First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)																	
Semester I																	
Sl. No.	Course Code	Course Type	Course Name	Credit Scheme			Teaching Scheme (Hours/Week)			Examination Scheme and Marks							
				TH	TUT	PR	L	T	P	CCE		ESE		PR	OR	TW	TOTAL
										UT	FA	SA					
1	MET26PCC-501	Programme Core Course	Embedded Physical Design of IoT	4			4				25	25	50			100	
2	MET26PCC-502	Programme Core Course	Smart Sensors and IoT	4			4				25	25	50			100	
3	MET26PCC-503	Programme Core Course - Lab	IOT Lab Practice –I			2			4					25	25	50	
4	MET26PEC-504	Programme Elective Course	Elective I	3			3				25	25	50			100	
5	MET26PEC-505	Programme Elective Course	Elective II	3			3				25	25	50			100	
6	MET26PEC-506	Programme Elective Course	Skill Based Laboratory I			2			4					25	25	50	
7	MET26 ELC-507	Experiential Learning Course (Research Methodology)	Research Methodology & IPR	4			4				25	25	50			100	
TOTAL				18	0	4	18		8		125	125	250		50	50	600
				22			26										

CCE- Comprehensive Continuous Evaluation, **ESE-** End Semester Evaluation, **TW-**Term Work, **OR-**Oral, **PR-** Practical, **TH-** Theory, **L-**Lecture, **T/TUT-**Tutorial, **UT-** Unit Test, **FA-**Formative Assessment, **SA –** Summative Assessment

Basket: List of Program Elective Courses -I

Course Code	Course Name	Choose Any One
MET26PEC-505A	Blockchain Technology	
MET26PEC-505B	AI & Machine Learning for IOT	
MET26PEC-505C	Wireless Sensor Networks for IOT	

Basket: List of Program Elective Courses–II

Course Code	Course Name	Choose Any One
MET26PEC-506A	IoT Security and Privacy	
MET26PEC-506B	Computational and Optimization Methods for IoT Systems	
MET26PEC-506C	IoT Machine Learning	

CURRICULUM STRUCTURE
First Year M. Tech. E and TC Engineering
(IoT and Sensor Systems)

Semester – II

First Year M. Tech. E and TC Engineering
(IoT and Sensor Systems)

Semester II

Sl. No.	Course Code	Course Type	Course Name	Credit Scheme			Teaching Scheme (Hours/Week)			Examination Scheme and Marks							
				TH	TUT	PR	L	T	P	CCE		ESE	PR	OR	TW	TOTAL	
										UT	FA	SA					
										25	25	50					
1	MET26PCC-551	Programme Core Course	Industrial Internet of things	4			4				25	25	50				100
2	MET26PCC-552	Programme Core Course	Embedded Technology and IOT	4			4				25	25	50				100
3	MET26PCC-553	Programme Core Course	Cloud Architecture and Protocol	4			4				25	25	50				100
4	MET26PCC-554	Programme Core Course - Lab	IOT Lab Practice – II			2			4						25	25	50
5	MET26PEC-555	Programme Elective Course	Elective – III	3			3				25	25	50				100
6	-	Open Elective Course	Elective – I	3			3				25	25	50				100
7	MET26ELC-557	Experiential Learning Course (Research Methodology)	Research Seminar – I			2			4						25	25	50
TOTAL				18	0	4	18		8		125	125	250		50	50	600
				22			26										

CCE- Comprehensive Continuous Evaluation, **ESE-** End Semester Evaluation, **TW-**Term Work, **OR-**Oral, **PR-** Practical, **TH-** Theory, **L-**Lecture, **T/TUT-**Tutorial, **UT-** Unit Test, **FA-**Formative Assessment, **SA –** Summative Assessment

Basket: List of Program Elective Courses–III

Course Code	Course Name	
MET26PEC-555A	5G and IoT Integration	Choose Any One
MET26PEC-555B	Electric Vehicles	
MET26PEC-555C	Smart Healthcare IoT Systems	

Basket: List of Open Elective Courses–I

Course Code	Course Name	
MCE26OEC-556A	Strategic Management and Business Analytics	Choose Any One
MCE26OEC-556B	Software Project Management	
MET26OEC-556	Cost Management of Engineering Projects	

CURRICULUM STRUCTURE
Second Year M. Tech. E and TC Engineering
(IoT and Sensor Systems)

Semester – III

Second Year M. Tech. E and TC Engineering																	
(IoT and Sensor Systems)																	
Semester III																	
Sl. No.	Course Code	Course Type	Course Name	Credit Scheme			Teaching Scheme (Hours/Week)			Examination Scheme and Marks							
				TH	TUT	PR	L	T	P	CCE		ESE	PR	OR	TW	TOTAL	
										UT	FA	SA					
1	MET26SLC-601	Self Learning Course	MOOC	4											100	100	
2	MET26ELC-602	Experiential Learning Course (OJT/Internship)	Internship			5				10					100	100	
3	MET26ELC-603	Experiential Learning Course (Research Methodology)	Research Seminar – II			4				8				25	25	50	
4	MET26ELC-604	Experiential Learning Course (Project)	Research Project - I			9				18				25	25	50	
TOTAL				4	0	18				34					50	250	300
				22			36										

CCE- Comprehensive Continuous Evaluation, **ESE-** End Semester Evaluation, **TW-**Term Work, **OR-**Oral, **PR-** Practical, **TH-** Theory, **L-**Lecture, **T/TUT-**Tutorial, **UT-** Unit Test, **FA-**Formative Assessment, **SA –** Summative Assessment

CURRICULUM STRUCTURE
Second Year M. Tech. E and TC Engineering
(IoT and Sensor Systems)

Semester – IV

Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)																	
Semester IV																	
Sl. No.	Course Code	Course Type	Course Name	Credit Scheme			Teaching Scheme (Hours/Week)			Examination Scheme and Marks							
				TH	TUT	PR	L	T	P	CCE		ESE	PR	OR	TW	TOTAL	
										UT	FA	SA					
											25	25	50				
1	MET26ELC-651	Experiential Learning Course (Research Methodology)	Research Seminar - III			4			8						50	50	100
2	MET26ELC-652	Experiential Learning Course (Project)	Research Project stage -II			18			36						50	150	200
TOTAL						22			44						100	200	300

Program	First Year M. Tech. (IoT and Sensor Systems)			Semester : I			
Course	Embedded Physical Design of IoT			Code:	MET26PCC-501		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
4	4	-	-	25	25	50	100

Pre-requisites: Basics of Embedded Systems and Microcontrollers, Fundamentals of Digital Electronics, Basic knowledge of Communication Systems, Programming knowledge (C/Python).

Course Objectives: This course aims at enabling students:

1. To Understand core concepts, architecture, and enabling technologies of IoT systems.
2. To Analyze IoT communication protocols and embedded interfacing techniques.
3. To Develop IoT systems by integrating sensors, actuators, and embedded platforms.
4. To Apply embedded physical design principles including PCB, power, and RF considerations.
5. To Design optimized and reliable IoT hardware systems for real-world applications.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Explain IoT architecture, components, and system-level design principles.

CO2: Analyze IoT communication protocols and embedded hardware interfaces.

CO3: Interface sensors/actuators and develop embedded IoT systems.

CO4: Apply embedded physical design techniques including PCB design, power, and thermal management.

CO5: Design and evaluate optimized IoT hardware systems for industrial and real-world applications.

Course Contents

Unit	Description	Duration [Hrs.]
I	<p style="text-align: center;">Unit I – IoT Fundamentals & Architecture</p> Definition, characteristics, and building blocks of IoT, IoT architecture: Physical & logical design, IoT enabling technologies, IoT communication models (overview), Design challenges: security, privacy, scalability, cost.	08
II	<p style="text-align: center;">Unit II – IoT Communication & Embedded Interfaces</p> IoT protocols: MQTT, CoAP (overview). Communication technologies: BLE, Zigbee, Wi-Fi, RFID, NFC. Embedded interfaces: I2C, SPI, UART, GPIO. Interfacing communication modules with embedded boards Signal integrity basics and noise considerations	09
III	<p style="text-align: center;">Unit III – Embedded Platforms, Sensors & Integration</p> Sensors & actuators: types, working, selection criteria. Physical integration of sensors. Embedded platforms (Raspberry Pi / equivalent): architecture, GPIO. Sensor interfacing (DHT11, PIR, Ultrasonic). Packaging basics and interconnect challenges. Case study: IoT sensor node.	09
IV	<p style="text-align: center;">Unit IV – Embedded Physical Design & PCB Design</p> Fundamentals of embedded physical design. Design constraints: power, size, cost, performance. PCB design principles: Single & multilayer boards, Routing techniques. Clock distribution and synchronization, Power optimization and thermal management, SoC and memory integration basics.	09

V	Unit V – Advanced Physical Design, RF & Applications RF design considerations: BLE, ZigBee, LoRa, Wi-Fi. Antenna basics for IoT devices. EMI/EMC and shielding techniques. Power-aware communication design. Case studies: Industrial IoT, Healthcare & wearable devices, Smart sensor node design (end-to-end).	10
	Total	45
Text Books:		
<ol style="list-style-type: none"> 1. Arshdeep Bahga & Vijay Madisetti – Internet of Things: A Hands-On Approach 2. Raj Kamal – Internet of Things: Architecture and Design Principles 3. Jan Rabaey – Digital Integrated Circuits: A Design Perspective 4. Simon Monk – Programming Raspberry Pi 		
Reference Books:		
<ol style="list-style-type: none"> 1. Olivier Hersent – IoT: Key Applications and Protocols 2. Mohammad Ali Mazidi – Embedded Systems with ARM Cortex-M Krzysztof Iniewski – Smart Sensors for Industrial IoT 3. David Harris – Digital Design and Computer Architecture 		
e-sources:		
<ol style="list-style-type: none"> 1. NPTEL – Introduction to IoT 2. NPTEL – Embedded Systems Design 3. Raspberry Pi Official Documentation 4. Coursera – IoT Specialization 		

	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	Smart Sensors and IoT			Code:	MET26PCC-502		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture`	Practical	Tutorial	UT	FA	SA	Total
4	4	-	-	25	25	50	100

Pre-requisites: Electrical and electronic engineering fundamentals, microcontroller fundamentals, computer networks and Internet concepts

Course Objectives: This course aims at enabling students:

1. To Develop a strong foundation in experimental data analysis by understanding error sources, statistical methods, probability distributions, and hypothesis testing relevant to sensor-based measurements.
2. To Understand principles and working of mechanical and electrical sensing devices for measuring pressure, flow, temperature, strain, displacement, and related physical parameters.
3. To Analyze and select appropriate measurement techniques and instruments such as oscilloscopes, DAQ systems, and digital/analog instruments for real-world engineering applications.
4. To Design and implement basic data acquisition and signal conditioning systems, including ADC/DAC interfacing and real-time data visualization using embedded platforms.
5. To Introduce smart sensors, embedded systems, and IoT fundamentals to enable intelligent sensing, remote monitoring, and data-driven decision-making in mechatronics and industrial applications.

Course Outcomes: After successful completion of the course, learner will be able to:

C01: Apply statistical techniques such as standard deviation, correlation coefficient, chi-square test, and Student's t-distribution to analyze experimental data and quantify measurement uncertainty.

C02: Explain and evaluate the operating principles, characteristics, and limitations of sensors used for pressure, flow, temperature, strain, and displacement measurements in mechanical and mechatronic systems.

C03: Select and justify suitable measurement instruments and sensing methods (analog/digital instruments, LVDT, strain gauges, flow meters, vacuum gauges) based on accuracy, sensitivity, and application constraints.

C04: Design a basic data acquisition system incorporating signal conditioning, ADC/DAC, microcontroller-based interfacing, and real-time data display or storage.

C05: Demonstrate conceptual and practical understanding of smart sensors and IoT-enabled systems, including embedded platforms, communication protocols (HTTP/MQTT), cloud-based data logging, and secure remote monitoring applications.

Course Contents

Unit	Description	Duration [Hrs]
I	Experimental Data Analysis and Basic Sensing Devices Types and causes of experimental errors, statistical analysis of experimental data, Normal distribution, chi-square test, Standard deviation, correlation coefficient, Student's t-distribution, Oscilloscopes, frequency counters, analog vs. digital instruments. General Considerations of Data Analysis.	09

II	<p>Mechanical Measurements -Pressure, Flow, Temperature, & Strain Distance Measurement using LVDT and Capacitive method Pressure Measurement- Diaphragm, bellows, Bridgman, Pirani, Knudsen, Ionization, Alphantron gauges Flow Measurement- Drag-based methods, hot-wire/film anemometers, Magnetic flow meters, Laser, Doppler Anemometer. Temperature Measurement- Thermocouples, compensation techniques, Heat flux, thermal conductivity, humidity and pH sensors Strain Measurement- Electrical resistance strain gauges, Rosette gauges.</p>	09
III	<p>Data Acquisition and Signal Processing Basic data acquisition system (DAQ), Signal conditioning techniques, ADC and DAC fundamentals and types of data transmission and display, Types of DAS and their life applications. Real-time data acquisition examples using microcontroller boards.</p>	09
IV	<p>Introduction to Smart Sensors and Embedded Systems Concept of smart sensors: self-calibration, diagnostics, signal conditioning, Comparison of conventional vs smart sensors, Basics of embedded systems: Microcontrollers (Arduino, ESP32 – overview only), Sensor interfacing basics (temperature, pressure, humidity), Role of firmware and analog-digital integration.</p>	09
V	<p>Fundamentals of IoT in Mechatronics IoT Definition and Architecture: Device, Network, Cloud, Common communication methods: Wi-Fi, Bluetooth (overview only), Introduction to cloud-based data logging (Thing Speak / Blynk – demonstration level), Basic IoT Protocols: HTTP and MQTT (conceptual overview only), Simple IoT applications in Mechatronics: 1) Remote temperature or vibration monitoring 2) Alert systems (email/SMS-based), Safety and security basics in IoT-enabled systems.</p>	09
	Total	45

Reference Books:

1. J. P. Holman, Experimental Methods for Engineers, McGraw Hill
2. K. P. Ramachandran, G. K. Vijayaraghavan, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India
3. R. K. Rajput, A Textbook of Mechatronics, S. Chand
4. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill India
5. Arshdeep Bahga & Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press
6. Bharat Sikka, Internet of Things (IoT), McGraw Hill India

e-sources:

1. NPTEL / SWAYAM: Courses on Mechatronics and IoT

Program	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	IOT Lab Practice -I			Code	MET26PCC-503		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
2	-	4	-		25	25	50
Pre-requisites: Basic gates, Number Systems							
Course Objectives: This course aims at enabling students: <ol style="list-style-type: none"> 1. To understand core concepts and protocols of IoT. 2. To design and implement embedded systems for IoT. 3. To apply computational and optimization methods for IoT systems. 							
Course Outcomes: After successful completion of the course, learner will be able to: <p>CO1: Design and model IoT architectures, embedded systems, and computational frameworks for real-world applications.</p> <p>CO2 Analyze IoT solutions with respect to scalability, constraints, optimization, and performance.</p> <p>CO3: Implement and validate IoT prototypes using modern tools, simulations, and optimization techniques.</p>							
Lab Practical							
Guidelines: <ol style="list-style-type: none"> 1. IoT Laboratory-I Experiments based on programme core courses. 2. Use available software/hardware. 							
Course Contents							
Sl. No.	Suggested List of Experiments/Assignments						
1	Part A: Principle of Internet of Things (Any 2)						
	<ol style="list-style-type: none"> 1. Design and develop a Zigbee-based device communication system using Raspberry Pi for remote LED control. 2. Implement and analyze an obstacle detection system using IR sensor and Raspberry Pi with LED indication. 3. Design and develop a smart streetlight control system using Raspberry Pi with adaptive light sensing. 4. Develop and evaluate a weather monitoring system using Raspberry Pi with humidity, temperature, and raindrop sensors. 5. Implement and test traffic signal control and smart health monitoring applications using Raspberry Pi/Arduino with alert mechanisms 						
2	Part B: Embedded Physical Design of IoT (Any 2)						
<ol style="list-style-type: none"> 1. Design and implement an embedded sensor node using Arduino/ESP32 — interface temperature and light sensors, read data, and send via serial/Wi-Fi. 							

	<p>2. Develop a low-power firmware routine for IoT devices — implement sleep/wake modes on ESP32/Arduino and measure power savings.</p> <p>3. Design and test signal conditioning and ADC interface — build an amplifier/filter for a sensor signal and acquire it with MCU ADC.</p> <p>4. PCB layout and prototype fabrication of a simple IoT breakout board — create schematic and PCB (KiCad), fabricate a single-board prototype and verify basic I/O.</p>
3	<p>Part C: Computational and Optimization Methods for IoT Systems (Any 2)</p> <p>1. Implement linear programming in Python to minimize energy consumption of IoT devices.</p> <p>2. Write a Python program to schedule IoT tasks using dynamic programming.</p> <p>3. Simulate shortest-path routing for IoT networks using Dijkstra’s algorithm.</p> <p>4. Apply Genetic Algorithm in Python for optimal sensor placement in a smart environment</p>
4	<p>Part D: Mini Project Based on IoT Applications such as:</p> <p>Smart Home, Smart Agricultural, E-health, Smart City, Smart Transportation, IOT Security using ML, etc.</p>

Program	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	Block chain Technology			Code:	MET26PEC-505A		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100
Pre-requisites: Computer Networks, Data Structures and Algorithms, Distributed Systems							
Course Objectives: This course aims at enabling students: <ol style="list-style-type: none"> To understand the fundamental concepts, architecture and cryptographic principles underlying blockchain and distributed ledger technologies. To explore various consensus mechanisms to achieve secure and reliable agreement in decentralized systems. To design and develop smart contracts, decentralized applications (DApps) To evaluate the application of blockchain frameworks in enterprise environments, decentralized finance (DeFi). To explore advanced trends and research directions for integrating blockchain with IoT, AI and Cloud technologies.. 							
Course Outcomes: After successful completion of the course, learner will be able to: <p>CO1: Analyze the evolution, architecture, and cryptographic foundations of blockchain systems.</p> <p>CO2: Design and evaluate smart contracts and decentralized applications (Dapps),</p> <p>CO3: Apply enterprise blockchain frameworks to evaluate cross-chain interoperability solutions.</p> <p>CO4: Assess decentralized finance (DeFi) applications and challenges in blockchain adoption.</p> <p>CO5: Investigate emerging blockchain research trends, integration with IoT, AI, and Cloud technologies.</p>							
Course Contents							
Unit	Description						Duration [Hrs]
I	Blockchain Foundations & Cryptography IoT Evolution of blockchain: Bitcoin to Web3, Blockchain architecture: Blocks, chains, nodes, P2P network, Permissioned vs. permission less blockchains, Distributed Ledger Technologies (DLT), Cryptographic principles: Hashing, Merkle Trees, Digital Signatures, Zero-Knowledge Proofs (zkSNARKs, zkSTARKs), Consensus mechanisms: Proof of Work (PoW), Proof of Stake (POS), Delegated Proof of Stake (Dapos), Practical Byzantine Fault Tolerance (PBFT), Directed Acyclic Graphs (DAG)						9
II	Smart Contracts & Decentralized Applications (Dapps) Smart contract fundamentals and design principles, Economic and legal aspects of smart contracts, Oracles and hybrid contracts: Conceptual overview, Security considerations: Common vulnerabilities, Mitigation strategies, Gas costs and optimization concepts.						9
III	Enterprise Blockchain Frameworks & Cross-Chain Interoperability Hyperledger Fabric, Corda, Quorum — architecture and use-cases, Cross-chain interoperability: Polka dot, Cosmos — concepts and industry relevance, Case studies and real-world examples.						9

IV	Decentralized Finance (DeFi), NFTs & Regulations DeFi ecosystem, NFTs, DAOs, CBDCs — trends and conceptual frameworks, Regulatory frameworks: GDPR, KYC and AML, compliance challenges, Sustainability and green blockchain initiatives.	9
V	Advanced Trends-IoT, AI, Cloud Integration Blockchain for IoT: Secure device identity, data integrity, Blockchain for AI: Data provenance, AI model trustworthiness, Blockchain for Cloud: case study of Decentralized storage, edge computing integration, Privacy-enhancing techniques: Mixers, ring signatures, confidential transactions.	9
	Total	45

Text Books:

1. Imran Bashir, Mastering Blockchain, 4th Edition, Packet Publishing, 2023.
2. Daniel Drescher, Blockchain Basics: A Non-Technical Introduction in 25 Steps, 1st Edition, A press, 2017.
3. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and Dapps, 1st Edition, O'Reilly Media, 2018.
4. Ritesh Modi, Solidity Programming Essentials, 2nd Edition, Packet Publishing, 2022.
5. Nitin Gaur, Luc Desrosiers, Venkatraman Ramakrishna, Petr Novotny, Anthony O'Dowd, Hands-On Blockchain with Hyperledger: Building Decentralized Applications with Course Contents Hyperledger Fabric and Composer, 1st Edition, Packet Publishing, 2018.
6. Nakul Shah, Blockchain for Business with Hyperledger Fabric, 1st Edition, Packet Publishing, 2018.
7. Arshdeep Bhaga, Vijay Madiseti, Blockchain Applications: A Hands-On Approach, 1st Edition, VPT, 2017.

Reference Books:

1. Roberto Infante, Building Ethereum Dapps, 1st Edition, Packet Publishing, 2019.
2. Kevin Solorio, Randall Kanna, David H. Hoover, Hands-On Smart Contract Development with Solidity and Ethereum: From Fundamentals to Deployment, 1st Edition, O'Reilly Media, 2019.
3. Dajani Mohanty, Corda in Action, 1st Edition, Manning Publications, 2021.

e-sources:

1. https://onlinecourses.nptel.ac.in/noc22_cs44/preview
2. https://onlinecourses.nptel.ac.in/noc19_cs63/preview
3. https://onlinecourses.nptel.ac.in/noc20_cs01/preview
4. https://onlinecourses.swayam2.ac.in/aic21_ge01/preview

Program	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	AI & Machine Learning for IOT			Code:	MET26PEC-505B		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100

Pre-requisites: Computer Networks, Basics of Linear Algebra, Basics of Python Programming Language.

Course Objectives: This course aims at enabling students:

1. **To gain** a fundamental understanding of Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT).
2. **To understand** data processing and analytics methods specific to IoT-generated data.
3. **To apply** AI techniques—including ML and Deep Learning (DL)—for enhancing data analysis, decision-making, and automation in IoT systems.
4. To explore strategies for deploying AI solutions across edge and cloud platforms in IoT architectures.
5. **To examine** domain-specific applications of AI in IoT through real-world case studies and practical insights.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: **Understand** the fundamental concepts of Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT)..
- CO2: **Analyze** and process IoT-generated data using appropriate data analytics techniques.
- CO3: **Design** and implement AI models, including ML and Deep Learning (DL) techniques, to support intelligent decision-making and automation in IoT systems.
- CO4: **Evaluate** and deploy AI solutions across edge and cloud computing platforms within IoT architectures.
- CO5: **Assess** real-world case studies to identify effective AI applications in various IoT domains such as healthcare, smart cities, and industrial automation

Course Contents

Unit	Description	Duration [Hrs]
I	<p style="text-align: center;">Understanding the Pillars of Intelligent Systems: AI, ML, and IoT</p> <p>IoT Fundamentals: Evolution, architecture (cloud, edge, fog), functional blocks (Sensors, Actuators) and communication Modules.</p> <p>AI & ML Fundamentals: Introduction to AI/ML concepts, programming languages (Python), algorithms, and frameworks</p>	9
II	<p style="text-align: center;">Data Processing and Analytics in the Internet of Things</p> <p>IOT Data Pre-processing: Data Preparation for Predictive Maintenance Modeling, Cleaning and Standardizing IoT Data, Applying Advanced Data Exploration Techniques</p> <p>Feature Engineering: Exploring Feature Engineering, Applying Feature Selection Techniques, Feature set selection using ML, Machine learning for Internet of Things data analysis</p>	9
III	<p style="text-align: center;">AI-Driven Methods for IoT</p> <p>Machine learning (ML) methods for IoT Applications: Decision Trees (DTs), Support Vector Machines (SVMs), Bayesian theorem-based algorithms, k-Nearest neighbor (KNN), Random Forest (RF), Association Rule (AR) algorithms, Ensemble learning (EL), k-Means clustering, Principal component analysis (PCA)</p>	9

	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)	
IV	AI Deployment in Edge and Cloud IoT Architectures 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.	9
V	AI, ML and IoT: Applications and Case-Based Insights Applications of AI, ML and IOT, Case Studies: IOT for Agriculture, Remote Patient Monitoring, Smart City, Smart Transportation, IOT Security using ML	9
	Total	45

Text Books:

1. Hatano Huang, Hao Yu, "Compact and Fast Machine Learning Accelerator for IoT Devices, "Edition: 1st ed. Publisher: Springer Singapore Year: 2019 ISBN: 978-981-13-3323-
2. 2. Ethem ALPAYDIN, "Introduction to Machine Learning", The MIT Press, October 2004, ISBN 0-262-01211-1
3. 3. Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2 nd Edition, Wiley Publications.
4. Arshdeep Bhaga and Vijay Madiseti, "Internet of Things: A Hands-On Approach", Orient Black swan Private Limited - New Delhi; First Edition (1 January 2015).

Reference Books:

1. Puneet Mathur, "IoT Machine Learning Applications in Telecom, Energy, and Agriculture, With Raspberry Pi and Arduino Using Python", ISBN 978-1-4842-5549-0
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. Trevor Hastie Robert Tibshirani Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition, Springer Series in Statistics, Feb 2009
5. Nicolas Modrzyk, "Real-Time IoT Imaging with Deep Neural Networks - Using Java on the Raspberry Pi 4", Après Publication, Year: 2020, ISBN: 9781484257210, 978148425722

e-sources:

1. https://onlinecourses.nptel.ac.in/noc26_cs38/preview
2. <https://nptel.ac.in/courses/106106139>
3. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
4. <https://elearn.nptel.ac.in/shop/iit-workshops/ongoing/computer-science/ai-for-iot-and-cyber-security/?v=13b5bfe96f3e>

Program	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	Wireless Sensor Networks for IOT			Code:	MET26PEC-505C		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100

Pre-requisites: Basics of IoT, Basics of Networking.

Course Objectives: This course aims at enabling students:

1. **To give** insight to various platforms needed for Embedded Technologies and IoT.
2. **To provide** in-depth knowledge of Wireless Sensor Networks (WSNs) and their role in IoT systems.
3. **To analyze** architectures, protocols, and design considerations in large-scale WSN deployments.
4. **To study** MAC, routing, and synchronization issues specific to IoT-enabled WSNs.
5. **To understand** energy-efficient design strategies and optimization techniques for WSN nodes.
6. To explore integration of WSNs with IoT network architectures, edge, and cloud layers.insights.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Understand advanced WSN concepts, architectures, and enabling technologies for IoT.

CO2: Apply appropriate MAC and routing protocols for designing energy-efficient and scalable IoT-based WSN solutions for given scenarios.

CO3: Analyze the performance of addressing, synchronization, and data management techniques in different WSN environments.

CO4: Design IoT network architectures incorporating WSN nodes and gateways.

CO5: Evaluate performance and optimization issues in WSN-enabled IoT systems.

Course Contents

Unit	Description	Duration [Hrs]
I	Overview of Wireless Sensor Networks for IoT Introduction of WSN, Characteristics of WSNs vs. traditional networks, Design constraints and challenges: scalability, heterogeneity, QoS, fault tolerance, Scope of WSN in IoT applications, Enabling technologies for WSNs in IoT	9
II	Sensor Node and Network Architectures Advanced single-node architecture: sensing, computation, communication, and power units, Hardware components and energy consumption models, Operating systems and execution environments (Tinos, Contiki, RIOT) , Network topologies: star, mesh, hybrid architectures.	9
III	Communication and MAC Protocols Physical layer considerations and transceiver design, MAC protocols: contention-based (CSMA, PAMAS), schedule-based (TDMA, FDMA, CDMA, LEACH), Low duty cycle protocols and wake-up radio concepts, Standards relevant to IoT: IEEE 802.15.4, 802.15.4e TSCH, 6LoWPAN	9
IV	Routing, Addressing, and Synchronization Routing protocols: flat, hierarchical, location-based approaches, Energy-efficient routing protocols (LEACH, PEGASIS, geographic routing), Address and name management in WSNs for IoT, Synchronization issues and techniques in distributed sensor networks, Security challenges: confidentiality, authentication, resilience	9

V	Data Management, Reliability, and Integration with IoT Architectures Data aggregation, fusion, and in-network processing, Gateway concepts and WSN-IoT integration strategies, IoT network architectures: oneM2M, IoT World Forum models, Edge and fog computing with WSNs: performance trade-offs, Reliability and fault tolerance mechanisms in WSNs, Optimization goals: energy efficiency, lifetime maximization, QoS trade-offs, Future trends: AI/ML integration in WSNs, cross-layer design approaches	9
		45
Text Books:		
<ol style="list-style-type: none"> 1. Holger Karl & Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005. 2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks – An Information Processing Approach”, Elsevier, 2007. 3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Jerome Henry, Robert Barton, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for IoT”, Cisco Press, 2017. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Ian F. Akyildiz and Mehmet Can Vuran, “Wireless Sensor Networks”, John Wiley & Sons, 2010. 2. Kazem Sohrab, Daniel Minoli & Tayeb Znati, “Wireless Sensor Networks: Technology, Protocol’s, and Applications, Wiley, 2007. 3. Raj Kamal, “Internet of Things: Architecture and Design Principles” , McGraw Hill Education, 2017. 		
e-sources:		
<ol style="list-style-type: none"> 1. http://youtube.com/watch?v=TrFaCBV7joY 2. https://www.youtube.com/live/5ZFFqhdf0QI?app=desktop&t=2941s 3. http://digimat.in/nptel/courses/video/106105160/L22.html 4. https://www.youtube.com/watch?v=gWu2Jxfae74 		

Program	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	IoT Security and Privacy			Code:	MET26PEC-506A		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100

Pre-requisites: Wireless Communication Technology

Course Objectives: This course aims at enabling students:

1. To introduce the architecture of IoT systems, their unique constraints, and the importance of security and privacy in IoT environments.
2. To provide an in-depth understanding of IoT threat models, vulnerabilities, cryptographic techniques, and secure communication mechanisms.
3. To enable students to analyze, design, and evaluate secure IoT solutions by integrating network, privacy, trust, and regulatory considerations.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Explain IoT architecture, communication models and device characteristics. Also can identify fundamental security and privacy challenges.
- CO2: Analyze IoT threat models, vulnerabilities, and attack surfaces to propose basic defensive strategies.
- CO3: Apply cryptographic techniques, authentication mechanisms, and access control models to secure IoT systems.
- CO4: Design secure network infrastructures, backend systems, and privacy-preserving frameworks for IoT.
- CO5: Evaluate emerging IoT security trends, case studies, and regulatory standards to ensure compliance and future readiness.

Course Contents

Unit	Description	Duration [Hrs]
I	IoT Architecture, Ecosystem, and Security Basics IoT ecosystem, IoT architecture layers, IoT communication models, IoT device characteristics, resource constraints in IoT, heterogeneity and interoperability issues, introduction to IoT security, privacy concerns in IoT, overview of security challenges and solutions.	9
II	Threat Models, Vulnerabilities and Attacks in IoT IoT threat surfaces, attack vectors in IoT devices and networks, sensor-level attacks, RFID vulnerabilities, routing and denial-of-service attacks, firmware and hardware exploitation, physical security threats, side- channel attacks, privacy breaches, attack modeling and classification frameworks.	9
III	Cryptography, Authentication, and Access Control Lightweight cryptography for IoT, symmetric and asymmetric cryptographic techniques, key establishment and management, device and user authentication, secure communication protocols (TLS, DTLS, CoAP, MQTT), identity management systems, role-based and attribute-based access control models, capability- based security mechanisms.	9

IV	<p style="text-align: center;">Network, Infrastructure and Privacy Security</p> <p>Security across IoT communication layers (physical, link, network, transport, application), secure M2M communication, intrusion detection and prevention in IoT networks, cloud and fog security, backend infrastructure security, secure data storage, secure resource management, database protection, privacy risks in IoT data collection, privacy-enhancing technologies (anonymization, pseudonymization, differential privacy), privacy-aware data aggregation, blockchain-based privacy approaches, trust models, policy-based trust management, consent frameworks.</p>	9
V	<p style="text-align: center;">Emerging Trends, Case Studies, and Regulations</p> <p>AI/ML-based intrusion detection in IoT, reinforcement learning for IoT security, edge and fog security models, zero-trust security architecture, IoT security testbeds and frameworks, smart home security, industrial IoT security, healthcare IoT security, IoT standards, regulatory policies, and legal compliance frameworks.</p>	9
	Total	45
<p>Text Books:</p> <ol style="list-style-type: none"> Souvik Pal, Vicente García Díaz, and R. P. Mohanty, "IoT: Security and Privacy Paradigm", 1st Edition, CRC Press, 2022. Brij B. Gupta, "Internet of Things Security: Principles, Applications, Attacks and Countermeasures", 1st Edition, CRC Press, 2020. B. B. Gupta, M. Quamina, and N. Kumar, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations", 1st Edition, Springer, 2020. 		
<p>Reference Books:</p> <ol style="list-style-type: none"> Brij B. Gupta, "A Beginner's Guide to Internet of Things Security: Attacks, Applications, Authentication Fundamentals and Security", 1st Edition, CRC Press, 2020. K. Loupes, "Holistic IoT Security, Privacy and Safety", 1st Edition, Now Publishers, 2025. H. Suo, J. Wan, C. Zou, and J. Liu, "Security in the Internet of Things: A Review", 1st Edition, Springer, 2012. 		
<p>e-sources:</p> <ol style="list-style-type: none"> https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html https://archive.org/details/microelectronicc00sedr NPTEL Course Analog Electronic Circuits 108105158/ https://nptel.ac.in/courses/108/105/ NPTEL Course on Analog Circuits: https://nptel.ac.in/courses/108101094 		

Program	First Year M. Tech. (IoT and Sensor Systems)			Semester : I			
Course	Computational and Optimization Methods for IoT Systems			Code:	MET26PEC-506B		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
4	4	-	-	25	25	50	100

Pre-requisites: Knowledge to handle the complex mathematical models and programming-intensive nature of the course.

Course Objectives: This course aims at enabling students:

1. To formulate and model real-world IoT challenges (such as energy consumption and network latency) using mathematical and computational approaches.
2. To apply classical and advanced optimization methods to develop efficient and scalable IoT solutions.
3. To design algorithms and protocols that address IoT constraints like limited power, memory, and processing capabilities.
4. To evaluate the performance and efficiency of computational techniques in distributed IoT environments.
5. To utilize modern computational tools and simulation platforms to implement and test optimization strategies for IoT applications..

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Students can articulate a given IoT problem as a well- defined mathematical optimization problem, identifying objective functions, variables, and constraints.
- CO2: Students can implement and apply a range of algorithms, including linear programming, dynamic programming, and metaheuristics (e.g., genetic algorithms, particle swarm optimization), to optimize IoT system performance.
- CO3: Students can design and evaluate energy-aware routing protocols, efficient data aggregation schemes, and optimal task scheduling algorithms for IoT devices and networks.
- CO4: Students can critically analyze and compare the trade-offs between different optimization strategies in terms of computational complexity, solution quality, and resource utilization.
- CO5: Students are skilled in using simulation tools and programming languages (like Python) to implement and validate their computational and optimization solutions for practical IoT scenarios such as smart cities, precision agriculture, or industrial automation.

Course Contents

Unit	Description	Duration [Hrs.]
I	<p style="text-align: center;">Unit I - Mathematical Foundations for IoT</p> <p>Linear Algebra: Concepts such as matrix operations, determinants, and eigenvectors. Emphasis on Singular Value Decomposition (SVD) and Principal Component Analysis (PCA) for data reduction and feature extraction from vast amounts of sensor data. Probability and Statistics: Advanced topics including stochastic processes, queuing theory, and Bayesian inference. Numerical Methods: Numerical solution of differential equations, interpolation, and regression analysis, focusing on their use for sensor calibration and data reconstruction.</p>	09
II	<p style="text-align: center;">Unit II - Classical and Deterministic Optimization</p> <p>Unconstrained Optimization: In-depth study of gradient descent, Newton's method, and conjugate gradient algorithms for finding local minima in cost functions. Constrained Optimization: Introduction to Lagrange multipliers and the Karush-</p>	09

	Kuhn-Tucker (KKT) conditions for solving optimization problems with equality and inequality constraints. Linear Programming: The Simplex method and duality theory. Applications will include optimizing network flow, assigning tasks to devices, and managing energy budgets. Dynamic Programming: The principle of optimality and its application to solving sequential decision-making problems, such as optimal routing and task scheduling in IoT networks.	
III	Unit III - Optimization in Distributed and Networked Systems Network Optimization: Algorithms for energy-efficient routing (e.g., Dijkstra's variant for energy cost), load balancing, and Quality of Service (QoS) in wireless sensor networks and Low-Power Wide-Area Networks (LPWANs). Edge and Fog Computing: Optimization models for task offloading and resource allocation between edge devices and cloud servers to minimize latency and bandwidth consumption. Data Aggregation and Fusion.	09
IV	Unit IV - Computational Intelligence and Heuristic Methods Metaheuristic Algorithms: A study of Genetic Algorithms (GAs), Simulated Annealing, and Particle Swarm Optimization (PSO). These are used for problems where an optimal solution is computationally intractable, such as sensor placement or complex routing. Machine Learning and Optimization: The role of optimization in training machine learning models for IoT applications like anomaly detection, predictive maintenance, and pattern recognition. Reinforcement Learning: An introduction to RL frameworks for autonomous decision-making in a dynamic IoT environment, such as a self-configuring smart home or an autonomous vehicle.	09
V	Unit V - Security, Privacy, and Practical Implementation Security & Privacy Optimization: Optimizing cryptographic key distribution, designing secure routing protocols, and using optimization to identify and mitigate cyber threats in real-time. Simulation and Emulation: Hands-on labs using tools like NS-3 or GNS3 for network simulation and Tensor Flow Lite for implementing machine learning models on resource-constrained devices like Raspberry Pi or ESP32. Case Studies: A project-based component where students apply the concepts to a real-world problem. Examples include optimizing an agricultural sensor network, designing a smart grid energy management system, or creating a healthcare monitoring system with a focus on data privacy.	09
	Total	45

Text Books:

1. Mathematics for Machine Learning" by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong
2. Convex Optimization" by Stephen Boyd and Lieven Vandenberghe
3. Distributed Optimization and Statistical Learning via the Alternating Direction Method of Multipliers" by Stephen Boyd et al

Reference Books:

1. Introduction to Linear Algebra" by Gilbert Strang
2. Numerical Methods for Engineers" by Steven C. Chopra and Raymond P. Canale.
3. Numerical Recipes: The Art of Scientific Computing" by William H. Press et al
4. The Internet of Things: From Machine-to-Machine to the Internet of Everything by P. H. E. van der Berg et al.
5. Pattern Recognition and Machine Learning by Christopher Bishop (for Module 4)
6. For practical applications: Relevant IEEE and ACM journal papers, tutorials on platforms like Timmy, and open-source documentation for IoT hardware and software
7. Hands-On Artificial Intelligence for IoT by Rajesh Kumar Dhanaraj and Balamurugan Balusamy.

e-sources:

1. NPTEL: Linear Algebra – covers matrix operations and eigenvalues
<https://www.nptelprep.in/courses/108104174>
2. NPTEL: Probability and Statistics – fundamentals of probability/statistics https://onlinecourses-archive.nptel.ac.in/noc19_ma08/course
3. NPTEL: Optimization – basic optimization methods
<https://www.nptelprep.in/courses/106101466/videos>

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : I			
Course	IoT Machine Learning			Code:	MET26PEC-506C		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100
Pre-requisites: Engineering Mathematics (Linear Algebra, Probability & Statistics, Calculus), Digital signal processing, Data Structures and Algorithms							
Course Objectives: This course aims at enabling students: <ol style="list-style-type: none"> 1. Introduce fundamental Machine Learning concepts and their applications in real-world problems. 2. Implement regression and classification models to solve engineering problems 3. Apply clustering and dimensionality reduction techniques to unlabeled data. 4. Optimize datasets through preprocessing and feature selection for Machine Learning pipelines. 							
Course Outcomes: After successful completion of the course, learner will be able to: <p>C01: Compare Machine Learning paradigms for real time applications</p> <p>C02: Design regression models for predictive tasks and classification models for signal/label prediction.</p> <p>C03: Develop clustering models and PCA-based solutions for defect detection or customer segmentation.</p> <p>C04: Construct feature engineering pipelines to improve model performance in IoT/telecom datasets.</p> <p>C05: Implement ensemble techniques to enhance accuracy in IC testing or power grid stability</p>							
Course Contents							
Unit	Description						Duration [Hrs]
I	Introduction to Machine Learning: Introduction, Definition and motivation, History and evolution of Machine learning, types: Supervised, Unsupervised, Semi-supervised, Reinforcement, Machine Learning Models: Geometric, Probabilistic, Logical, and Parametric. Non-parametric, Applications of Machine Learning in Signal processing, speech recognition, image processing, Wireless communications						9
II	Supervised Machine Learning: Introduction to Supervised Learning, Types of Supervised Problems, Regression Models: Linear Regression, Types of Linear Regression, cost function, gradient descent of linear regression, Evaluation Metrics for Linear Regression. Classification Models: Logistic Naive Bayes algorithm KNN algorithm Support Vector Machine (SVM).						9
III	Unsupervised Machine Learning: Introduction, Types of Unsupervised Learning: Clustering, Association Rule Learning, Dimensionality Reduction, K-means Clustering algorithm, Evaluation: Elbow method, Silhouette score, Density-Based Methods, Dimensionality Reduction Techniques, Principal Component Analysis (PCA), Apriorism: PGP, S/MIME. Firewall.						9
IV	Feature Engineering: Importance of feature engineering in Machine Learning pipeline, handling missing values, outliers, encoding: Label, One-Hot, Ordinal, Target Scaling: Min-Max, Standardization, Normalization, Feature selection: Filter (Chi-square), Wrapper (RFE), Embedded (Lasso).						9

V	Ensemble Learning and Model Evaluation: Introduction to Ensembles, Need of Ensemble Learning, Basic Ensemble Learning Techniques: Voting (Hard/Soft), Advanced Ensemble Learning Techniques: Bagging (Random Forest), Boosting (AdaBoost, XGBoost), Stacking, Cross-validation: Hold-out, K-Fold, LOOCV, Model comparison using t-test, McNemar's test, Hyperparameter tuning (Grid Search, Random Search)	9
	Total	45
Text Books:		
<ol style="list-style-type: none"> 1. Ethem Alpaydin, "Introduction to Machine Learning", Publisher: The MIT Press, 2014 2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, Edition 2012. 		
Reference Books:		
<ol style="list-style-type: none"> 1. Ian H Witten, Eibe Frank, Mark A Hall, "Data Mining, Practical Machine Learning Tools and Techniques", Elsevier, 3rd Edition 2. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807 3. Shalev-Shwartz, Shai, and Shai Ben-David, "Understanding machine learning: From theory to algorithms", Cambridge university press, 2014 4. McKinney, "Python for Data Analysis O' Reilly media, ISBN : 978-1-449- 31979-3 		
e-sources:		
<ol style="list-style-type: none"> 1. Introduction to Machine Learning(IIT kharagpur) : https://nptel.ac.in/courses/106105152 2. Introduction to Machine Learning (IIT Madras)https://onlinecourses.nptel.ac.in/noc22_cs29/preview 3. Machine Learning A-Z™: AI, Python & R https://www.udemy.com/course/machinelearning/ 4. Machine Learning and Deep Learning A-Z: Hands-On Python https://www.udemy.com/course/machine-learning-and-deep-learning-a-z-hands-on-python/ 		

Program	First Year M. Tech. (E and TC)- IoT and Sensor Systems			Semester : I			
Course	Skill Based Laboratory I			Code	MET26PEC-506		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
1	-	2	-		25	25	50
Pre-requisites: Program Elective Course							
<p>Course Objectives: This course aims at enabling students:</p> <ol style="list-style-type: none"> 1. To provide advanced knowledge of Internet of Things (IoT) architectures, communication protocols, and wireless sensor networks used in smart environments. To design and implement embedded systems for IoT. 2. To develop an understanding of IoT security and privacy mechanisms, including encryption, authentication, access control, and attack mitigation techniques. CO3: Implement and validate IoT prototypes using modern tools, simulations, and optimization techniques. 3. To introduce blockchain fundamentals and decentralized systems for secure, transparent, and tamper-proof IoT applications. 4. To apply Artificial Intelligence and Machine Learning techniques for analyzing IoT data, enabling intelligent decision-making and predictive analytics. 5. To explore energy-efficient routing, data aggregation, and communication strategies in wireless sensor networks for scalable IoT systems. 6. To design and implement secure, intelligent, and decentralized IoT applications using emerging technologies such as blockchain, edge computing, and machine learning. 							
<p>Course Outcomes: After successful completion of the course, learner will be able to:</p> <p>CO1: Analyze IoT system architecture and implement secure communication protocols for connected devices.</p> <p>CO2: Apply cryptographic techniques, authentication mechanisms, and access control models to enhance IoT security and privacy.</p> <p>CO3: Develop blockchain-based applications and smart contracts for secure and transparent data management.</p> <p>CO4: Implement machine learning models for IoT data analytics, anomaly detection, and predictive maintenance.</p> <p>CO5: Evaluate and implement energy-efficient routing protocols and MAC protocols in wireless sensor networks.</p> <p>CO6: Design and deploy integrated IoT solutions combining security, blockchain, and AI/ML for real-world applications.</p>							
Lab Practical							
Guidelines:							
Skill Based Laboratory are based on the electives chosen by the students.							
List of Assignments							
Sl. No.	Suggested List of Experiments/Assignments						
	Select practical experiments from Part A (any 3) and Mini- Project from Part B. .						
	Part A - Practical						

1	<p style="text-align: center;">Part A- IoT Security & Privacy</p> <ol style="list-style-type: none"> 1. Implement symmetric and asymmetric encryption (AES, RSA) on IoT data collected from sensors and analyse performance overhead. 2. Configure secure communication between IoT devices using TLS/DTLS over MQTT or CoAP. 3. Develop and test a lightweight authentication mechanism (e.g., token-based authentication) for an IoT edge device. 4. Demonstrate role-based or attribute-based access control for IoT devices in a smart home/industrial setup. 5. Simulate common IoT network attacks (e.g., DoS, replay attack, spoofing) and evaluate defense mechanisms. 6. Implement privacy-preserving data aggregation using anonymization/pseudonymization techniques for IoT sensor data.
2	<p style="text-align: center;">Part A -Blockchain</p> <ol style="list-style-type: none"> 1. Write a program to simulate a blockchain with multiple blocks using hashing and a simple Proof-of-Work mechanism. 2. Design and deploy a simple smart contract using Solidity on Remix IDE and test it on an Ethereum test network. 3. Simulate a consensus mechanism using Python or an online tool and demonstrate how nodes agree on the next block even in the presence of faulty nodes.
3	<p style="text-align: center;">Part A – AI & Machine Learning For IOT</p> <ol style="list-style-type: none"> 1. Pre-process IoT sensor data and apply feature selection. 2. Implement classification using Decision Tree / Random Forest / SVM. 3. Apply clustering (k-Means / DBSCAN) on IoT datasets. 4. Implement CNN / RNN for IoT applications. 5. Deploy a lightweight ML model on Raspberry Pi / ESP32. 6. Train an ML model for intrusion detection using IoT security data.
4	<p style="text-align: center;">Part A- Wireless Sensor Network for IoT</p> <ol style="list-style-type: none"> 1. Simulation of different WSN network topologies (star, mesh, hybrid). 2. Implementation of CSMA and TDMA-based MAC protocols. 3. Energy-efficient routing using LEACH or PEGASIS. 4. Data aggregation and fusion in a WSN test scenario. 5. Integration of WSN with IoT cloud using a gateway (e.g., MQTT/6LoWPAN). <p>Part B:</p>
	<p>Part B: Mini project</p>

5	<p>1. Blockchain - To design and implement a blockchain-based voting system where votes are securely stored, tamper-proof, and transparently counted using Ethereum smart contracts</p> <p>2. Wireless Sensor Network for IoT – Design and implement an energy-efficient routing protocol (LEACH/PEGASIS) for a WSN testbed and evaluate performance.</p> <p>3. IoT Security & Privacy – Develop a secure IoT healthcare monitoring system with encrypted communication and role-based access control.</p> <p>4. AI & Machine Learning for IoT – Build and deploy a machine learning-based predictive maintenance model using IoT sensor data on an edge device.</p>
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Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: I			
Course	Research Methodology & IPR			Code:	MET26ELC-507		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
5	4	-	-	25	25	50	100

Pre-requisites: Cloud Computing, Embedded System and IoT.

Course Objectives: This course aims at enabling students:

1. To explore the fundamentals and basic concepts of Edge and Fog Computing.
2. To design and integrate different services of Edge and Fog computing with IoT.
3. To analyze and summarize different applications of Edge and Fog computing across multiple domains.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Define a research problem and use appropriate research methodology
CO2: Examine data using different hypothesis tests and make conclusions about acceptance or rejection of sample data.
CO3: Analyze numerical data, using standard procedures of probability theory to predict the Performance.
CO4: Develop a mathematical model and analyze the prediction capabilities
CO5: Write a research paper and research proposal.

Course Contents

	Description	Duration [Hrs.]
I	Research Problem and Research Design Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research Definition and Feasibility study of research problem, Sources of research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design	9
II	Applied Statistics Measures of Variability: Standard Deviation, variance, Quartiles, Interquartile Range Inferential Statistics: Statistical Significance (p values), Pearson"s r test, t-test, Chi square test	9
III	Probability Sampling, Types of Sampling, Probability Distribution: Binomial Distribution, Poisson Distribution, Normal Distribution, Case Study: Develop a model for Prediction and Decision Making for the data set using open source software.	9
IV	Research Report writing and Publication Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing. Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, identifying indexing of selected journals, Impact factor of the journal, structure of	9

	research paper, Check for plagiarism of the article, Research paper submission and review process.	
V	Intellectual property Rights Definition of IPR, Classification of IP, Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents. Prior Art Search, Patentability Criteria, Patent Filing Procedure, Forms and Fees, Case Study of Patent, Copyright.	9
	Total	45

Text Books:

1. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, 2nd Edition, 1985
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition.,2010.
3. Ramakrishna B and Anil Kumar H S., Fundamentals of IPR, Notion Press, 2016
4. Virendra Kumar Ahuja, IPR in India, LexisNexis Butterworths Wadhwa Nagpur, 2017

Reference Books:

1. Stuart Melville and Wayne Goddard, Research methodology: An Introduction for Science & Engineering Students
2. S.D. Sharma, Operational Research, Kadar Nath Ram Nath & Co.

e-sources:

1. https://www.youtube.com/playlist?list=PLm-zueI9b64QGMcfn5Ckv_8W5Z1d3vMBY
2. https://onlinecourses.swayam2.ac.in/cec20_hs17/preview
3. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Course Syllabus

Semester-II

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : II			
Course	Industrial Internet of things			Code:	MET26PCC-551		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
4	4	-	-	25	25	50	100

Pre-requisites: Fundamentals of Communication and Computer Network, Computer Network Technology, Internet of Things.

Course Objectives: This course aims at enabling students:

1. To understand what is Industrial Internet of Things.
2. To Describe architecture, Design, underlying technologies, Security and Standards.
3. To understand industrial application of IoT

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Explain what is Industrial Internet of Things.
CO2: Explain architecture and underlying addressing techniques
CO3: Understand the Data Acquisition and Processing techniques.
CO4: Understand IIOT Security and Standards.
CO5: Understand industrial application of IoT

Course Contents

Unit	Description	Duration [Hrs]
I	<p style="text-align: center;">Introduction To Industrial IoT</p> <p>What is the Internet of Things? Internet of Things Definitions and Frameworks: IoT Definitions, IoT Architecture, IoT levels and Deployment templates: Level 1 to Level 5, IoT Enabling Technologies: WSN, cloud computing, Big data Analytics, communication Protocols, Embedded systems, Overview of IoT vs. IIOT, Key characteristics and requirements of IIOT, IIOT reference architectures (RAMI 4.0, IIRA)</p>	09
II	<p style="text-align: center;">IIoT Communication, Addressing And Networking</p> <p>The one M2M IoT Standardized Architecture, The IoT World Forum (IOTWF) Standardized Architecture, A Simplified IoT Architecture, IoT protocol stack, Communication protocols for IIOT: MQTT, CoAP, OPC-UA, DDS, Modbus, PROFINET, Address Capabilities, IPv6 Protocol Overview, IPv6 Tunneling, IPsec in IPv6, Header Compression Schemes, Quality of Service in IPv6, Industrial networking standards (Ethernet/IP, Wireless HART, 6LoWPAN), Edge, Fog, and Cloud computing in IIOT, Time-sensitive networking (TSN).</p>	09
III	<p style="text-align: center;">Data Acquisition And Processing</p> <p>Data acquisition from industrial machines and sensors, SCADA systems and PLCs integration with IoT, Data storage (time-series databases, cloud storage), Introduction to cloud storage models and communication API's, Data analytics: predictive maintenance, anomaly detection, process optimization, Role of AI/ML in IIOT.</p>	09

IV	IIoT Security And Standards Security challenges in IIOT: device security, data privacy, network security, Threats: spoofing, denial of service, malware in industrial environments, Security mechanisms: authentication, encryption, blockchain for IIOT, Industrial standards and regulatory compliance (IEC 62443, ISO 27001, NIST guidelines), Resilience and safety in IIOT systems.	09
V	Applications And Case Studies Smart manufacturing and Industry 4.0, Predictive maintenance and digital twins, Smart energy management and smart grids, IIOT in logistics and supply chain management, Future trends: 5G, AI- driven IIOT, Cyber-physical systems, Case studies of IIOT communication in industries.	09
	Total	45

Text Books:

1. Internet of Things: A Hands-On Approach Arshdeep Bhaga, Vijay Madiseti VPT – Paperback 2015 978- 0996025515 628/- 2
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things David Hanes, Gonzalo Salgueiro, Patrick Grossetete Cisco Press – Paperback – 16 Aug 2017 978-1-58714-456- 1 599/-
3. Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications Daniel Minoli Willy Publication s - 2013 978-1-118- 47347-4, 466/-
4. Industrial Internet of Things: Cyber manufacturing Systems – Sabina Jeschke et al.
5. Architecting the Industrial Internet – M. Jamshidi
6. Designing Connected Products: UX for the Consumer Internet of Things – Claire Rowland et al.

Reference Books:

1. Smart Internet of things projects Agus Kurniawan Packt - Sep 2016 978-1- 78646- 651-8 2 The Internet of Things Key Olivier Willy Publication 2nd Edition 978-
2. Applications and protocols Hersent s 119- 99435-0, 3 The Internet of Things Connecting Objects to the Web Hakima Chaouchi, Willy Publications 978-1- 84821- 140-7

e-sources:

1. <https://nptel.ac.in/courses/106105195>
2. https://onlinecourses.nptel.ac.in/noc26_cs37/preview

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : II			
Course	Embedded Technology and IOT			Code:	MET26PCC-552		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
4	4	-	-	25	25	50	100

Pre-requisites: Embedded System and analog circuits

Course Objectives: This course aims at enabling students:

1. To give insight to various platforms needed for Embedded Technologies and IoT.
2. To expose students to the usage of protocol standardization in Embedded Technologies and It's selection to various applications.
3. To Understand the fundamental of sensors and actuators along with the basic concepts of an IoT and how to design IoT based applications.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Understand various Embedded platforms and IoT platforms.
CO2: Comprehend the operation of different buses and protocols.
CO3: Interpret IoT architecture design aspects and its analyze concepts.
CO4: Develop design skills in industrial IoT.
CO5: Provide suitable solution for specific application and illustrate the technologies of IoT using suitable case studies.

Course Contents

Unit	Description	Duration [Hrs]
I	<p style="text-align: center;">ARM, Raspberry Pi Microcontroller</p> <p>Basics of Raspberry Pi (RPi) board, Features and architecture, pin configurations, Installing OS on RPi, connecting to network, Programming languages with examples, Various interfaces e.g. I2C, UART, SPI, CAN. Node MCU ESP8266 Pin configuration, Station, AP, ST-AP modes, Node MCU as web server, posting sensor data to gateway.</p>	09
II	<p style="text-align: center;">Buses and Protocols</p> <p>CAN Bus: Features and applications, CAN Frame, sequence of transmitting and receiving data on CAN Bus. Ethernet and USB Bus: Features and applications. Protocols: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Bluetooth Low Energy, Zigbee Smart Energy, Network Layer-IPv4, IPv6, 6LoWPAN, Transport Layer (TCP, MPTCP, UDP) Session Layer HTTP, CoAP, XMPP, AMQP, MQTT</p>	09
III	<p style="text-align: center;">IoT Fundamentals</p> <p>IoT Architecture and Design Concepts: IoT – An architectural overview, Design Principles and capabilities, M2M & IOT Technology Fundamentals- End Devices and gateways, Local and wide area networking, Challenges Associated with IoT, Cloud Platforms for IoT. Sensors: Different types of sensors and Actuators, Working, Networking Basics, RFID Principals and components, Wireless Sensor Networks, Physical Design of an IoT, Logical design of IoT Communication Models, Communication API's, Concept of IoE, Difference between IoT and IoE.</p>	09

IV	Industrial IoT Introduction, Key Industrial IOT (IIOT) technologies, Catalysts, and precursors of IIOT, Innovation and the IIOT, Applications of IIOT Examples: Healthcare, Oil and Gas Industry, Logistics and the Industrial Internet, Retail applications, IoT innovations and design methodologies.	09
V	IoT Applications Applications: Smart Environment: Forest Fire Detection, Air Pollution, Smart Cities: Parking, Structural Health, Noise Urban maps, Smart Metering: Smart Grid, Tank level, Photovoltaic Installations, Health: Fall Detection, Medical Fridges, Sportsmen Care, Patients Surveillance.	09
	Total	45

Text Books:

1. Olivier Hersent, David Boswarthick, and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", 2nd Edition, Wiley Publications.
2. Arshdeep Bhaga and Vijay Madiseti, "Internet of Things: A Hands-On Approach", Orient Black Swan Private Limited - New Delhi; First Edition (1 January 2015).
3. Simon Monk, "Programming Raspberry Pi", McGraw Hill TAB; 2nd edition (16 November 2015).

Reference Books:

1. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide – Designing and Optimizing System Software", ELSEVIER
2. Dr. Ovidiu Vermes an, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series
3. Rajesh Singh, "Internet of Things with Raspberry Pi and Arduino", CRC Press 2020.

e-sources:

1. https://onlinecourses.nptel.ac.in/noc22_cs53
2. <https://nptel.ac.in/courses/108102045>
3. <https://www.udemy.com/course/embedded-system-for-internet-of-things-pna/?srsltid>

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : II			
Course	Cloud Architecture Protocols			Code:	MET26PCC-553		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
4	4	-	-	25	25	50	100

Pre-requisites: Embedded System and analog circuits

Course Objectives: This course aims at enabling students:

1. To define core cloud architecture principles using standardized models (NIST, SPI).
2. To analyze network protocol mechanics, including encapsulation systems and data centre topologies.
3. To evaluate security frameworks using cryptographic protocols and identity management algebras.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Classify cloud service/deployment models using NIST taxonomies and deconstruct virtualization architectures.
- CO2: Analyze encapsulation protocols and data center fabrics using routing algebras and congestion control formalisms.
- CO3: Analyze the components of a virtualized data center and review the performance of Data archiving solutions.
- CO4: Implement /identity cryptographic protocols via state-machine models and Zero Trust policy algebras.
- CO5: Quantify system resilience using queueing theory, failure distributions and resource optimization heuristics

Course Contents

Unit	Description	Duration [Hrs]
I	Cloud Ontology & Architectural Frameworks: Foundational Models: NIST essential characteristics, SPI service model taxonomy, resource abstraction layers. Deployment Topologies: Public, Private and Hybrid structural patterns, community cloud governance frameworks. Virtualization Theory: Hypervisor architectures (Bare-metal/Hosted), container isolation formalisms, docker basics and architecture.	09
II	Network Virtualization & Protocol Architectures: Encapsulation Systems: VXLAN/Geneve header structures, NVGRE protocol mechanics, virtual switching paradigms. Data Center Fabrics: BGP-EVPN control plane theory, Clos topology mathematics, spine-leaf routing algebras. Transport Layer Theory: TCP congestion control formalisms, QoS traffic shaping models, packet scheduling algorithms.	09
III	Storage Networks: Storage network design considerations: NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCOE), design for storage virtualization in cloud computing, host system design considerations. Replications in NAS and SAN environments. Data archiving solutions, analyzing compliance and	09

	archiving design considerations.	
IV	Security Protocols & Cryptographic Frameworks: Identity Systems: SAML 2.0 assertion flows, OAuth 2.0 grant type formalisms, RBAC/ABAC policy algebras. Cryptographic Systems: TLS 1.3 handshake state machine, AES-GCM mode operations, PKI trust hierarchies. Network Security Models: Zero Trust formal architectures, IPsec/IKEv2 tunneling protocols, firewall policy verification.	09
V	Scalability & Reliability Theory: Elasticity Frameworks: Autoscaling hysteresis models, M/M/c queueing systems, horizontal scaling proofs. Failure Engineering: Weibull failure distributions, RTO/RPO calculus, chaos engineering principles. Cost Governance Ontologies: TCO analytical frameworks, bin packing optimization, cloud governance taxonomies.	09
	Total	45

Text Books:

1. T. Erl et al., Cloud Computing: Concepts, Technology & Architecture. Upper Saddle River, NJ: Prentice Hall, 2013.
2. D. Dutt, Cloud Native Data Center Networking. Sebastopol, CA: O'Reilly Media, 2019.
3. B. Beyer et al., Site Reliability Engineering: How Google Runs Production Systems. Sebastopol, CA: O'Reilly Media, 2016.
4. C. Wu and R. Buyya, Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center. Cambridge, MA: Morgan 2015

Reference Books:

1. R. Mather et al., Cloud Security: A Comprehensive Guide to Secure Cloud Computing. Hoboken, NJ: Wiley, 2010.
2. P. Mell and T. Grance, The NIST Definition of Cloud Computing, NIST SP 800-145. Gaithersburg, MD: National Institute of Standards and Technology, 2011.
3. Azodol molky, Cloud Networking: Understanding Cloud-Based Data Center Networks. Waltham, MA: Morgan Kaufmann, 2014.

e-sources:

1. Cloud computing By Prof. Soumya Kanti Ghosh, IIT haragpur
https://onlinecourses.nptel.ac.in/noc21_cs14/preview
2. Advanced Computer Networks, By Prof. Neminath Hubballi, Prof. Sameer G Kulkarni IIT Indore, IIT Gandhi nagar https://onlinecourses.nptel.ac.in/noc25_cs02/preview

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: II			
Course	IOT Lab Practice - II			Code	MET26PCC-554		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
2	-	4	-	-	25	25	50
Pre-requisites: Internet of Things sensors platforms, PLC, Cloud platform, ML algorithms, Blockchain Technology.							
Course Objectives: This course aims at enabling students: <ol style="list-style-type: none"> 1. To understand Industrial Internet of Things sensor and its interfacing. 2. To Understand IIOT Security application. 3. To understand industrial application of IoT 							
Course Outcomes: After learning the course, the students should be able to: <p>CO1: Understand Industrial Internet of Things sensor and its interfacing.</p> <p>CO2: Understand the Data Acquisition and Processing techniques.</p> <p>CO3: Understand IIOT Security application.</p> <p>CO4: Understand cloud industrial application.</p> <p>CO5: Understand ML industrial application.</p> <p>CO6: Apply debugging strategies, UML modeling, and documentation standards to develop maintainable and scalable applications.</p>							
Course Contents							
Sl. No.	Suggested List of Experiments/Assignments (Minimum 6 to be performed)						
	Part A: Embedded Technology and IOT (Minimum 2 to be performed)						
1	IoT based stepper motor/ DC motor control using Raspberry-Pi.						
2	To use MQTT/ CoAP protocol and send sensor data to cloud using Raspberry-Pi/ ESP8266.						
3	To prepare IoT based small project implementation on the topics based on small problem statements of the fields like smart home (Home Automation) etc. This project can be built on any IoT simulation platform like Tinker cad, Coala etc						
	Part B: Smart Healthcare system for IOT (Minimum 2 to be performed)						
4	To develop IoT based heart rate and temperature monitoring system for Patient						
5	To develop IoT based smart medication reminder system for Patient.						
6	To utilize MQTT protocol and send bio-sensor data to cloud using Raspberry-Pi/ ESP8266.						
7	To prepare IoT based Patient-Room Environment Monitoring (Temp, Humidity, Air Quality. This project can be built on any IoT simulation platform like Tinker cad, Cooja etc.						
	Part C: 5G and IoT Integration (Minimum 2 to be performed)						
8	Design and simulation of a 5G-enabled smart city framework.						

9	Protocol performance comparison for industrial 5G-IoT .
10	Secure authentication for NB-IoT devices in 5G networks.
11	Machine Learning-based traffic management in 5G-IoT edge networks.

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : II			
Course	5G and IoT Integration			Code:	MET26PEC-555A		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100

Pre-requisites: Internet of Things Basics, Embedded System, and 5G Basics

Course Objectives: This course aims at enabling students:

1. To understand the Fundamentals of 5G Technology.
2. To explore IoT Concepts and Protocols.
3. To analyze the Synergy Between 5G and IoT.
4. To design and Develop 5G-Enabled IoT Systems.
5. To address Security and Privacy Challenges.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Provide a comprehensive understanding of 5G technologies and their suitability for large-scale IoT applications.
- CO2: Explore architectural frameworks and enabling technologies for integrated 5G-IoT systems.
- CO3: Analyze and critique key standards, protocols, and deployments.
- CO4: Investigate cutting-edge application and security aspects of 5G-enabled IoT systems.
- CO5: Encourage independent research and project-based learning in emerging 5G-IoT domains..

Course Contents

Unit	Description	Duration [Hrs]
I	Evolution and Convergence of 5G and IoT : Evolution of mobile networks from 1G to 5G, Technical overview of 5G: Use cases, capabilities, and KPIs, IoT ecosystem and architecture: Perception, network, application layers, Role of 5G in IoT: mMTC, URLLC, and eMBB, Convergence trends and vision of hyper-connected ecosystems	9
II	Network Architecture and Enablers for IoT : 5G NR architecture and protocol stack, Service-Based Architecture (SBA) and 5G Core, Network slicing for IoT verticals, Mobile Edge Computing (MEC) and Multi-access Edge Computing, Role of Massive MIMO, Beamforming, and mm Wave in IoT support, Software Defined Networking (SDN) and Network Function Virtualization (NFV).	9
III	Protocols, Standards, and Interoperability in 5G-IoT 3GPP standardization for IoT: NB-IoT, LTE-M, Rel-16 and beyond, IoT communication protocols over 5G: MQTT, CoAP, AMQP, DDS, 6LoWPAN, Interoperability issues in heterogeneous IoT-5G systems, Time- Sensitive Networking (TSN) for Industrial IoT over 5G, Data management and cloud-native architectures	9
IV	Applications, Case Studies, and Performance Evaluation : Smart cities, smart grids, precision agriculture, digital health, and autonomous systems, V2X (Vehicle-to- Everything) and Intelligent Transportation Systems, Industrial IoT (IIOT) and automation with 5G, Performance metrics: Latency, throughput, energy efficiency, reliability, Case studies: 5G-IoT deployments in Europe, Asia, and North America, Use of AI/ML in 5G-IoT for traffic	9

	prediction, anomaly detection, and optimization.	
v	Challenges, Security, and Future Research Directions: Security threats in 5G-enabled IoT: device, network, and data layers, Lightweight cryptography and identity management for constrained IoT, Privacy, ethical, and regulatory concerns, Open challenges: Mobility, scalability, spectrum, and backward compatibility, Research directions: 6G, digital twins, AI- native networks, Blockchain for IoT.	9
	Total	45

Text Books:

1. Erik Dahlman, Stefan Parkvall, Johan Skold "5G NR: The Next Generation Wireless Access Technology", Elsevier Academic Press.
2. Raj Kamal "Internet of Things: Architecture and Design Principles" McGraw Hill Education (India) Private Limited.
3. Afif Osseiran, Jose F. Monserrat "5G and Beyond: Fundamentals and Standards" Cambridge Press.

Reference Books:

1. Dr. Ovidiu Vermes an, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers Series
2. 3GPP Technical Reports and Specifications (www.3gpp.org)
3. IEEE Journals and Conferences on IoT and 5G
4. Whitepapers from Ericsson, Huawei, Qualcomm, Intel on 5G-IoT NIST and ETSI reports on IoT standardization and architecture

e-sources:

1. <https://www.coursera.org/learn/5g-training-qualcomm>

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : II			
Course	Electric Vehicles			Code:	MET26PEC-555B		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100
Pre-requisites: Power Electronics, Control Systems.							
Course Objectives: This course aims at enabling students: <ol style="list-style-type: none"> To distinguish between different configuration of electric vehicles with merits and demerits. To recommend drive for EV applications with suitable energy storage technology 							
Course Outcomes: After successful completion of the course, learner will be able to: <p>CO1: Explore the history, development, and configurations of EVs and hybrid EVs, focusing on efficiency and energy storage.</p> <p>CO2: Analyze EV battery specifications, charging cycles, drives, and converter topologies</p> <p>CO3: Examine energy sources, battery features, charging methods (conductive and inductive), and charging infrastructures, including domestic, public, and fast-charging stations.</p> <p>CO4: Select appropriate motor and converter for EV applications</p> <p>CO5: Study EV power devices, power electronics converters along with its switching methods for EV operation.</p> <p>CO6: Investigate particular drive for EV including speed control methods and advanced control strategies like FOC and adaptive control.</p>							
Course Contents							
Unit	Description						Duration [Hrs]
I	Introduction to EV: History and development of on-road Electric Vehicles (EV). Different configurations of hybrid EVs with block diagram representation, merits & demerits of different configurations in view of vehicle efficiency and energy storage system						9
II	Basics of EV batteries: Specifications of batteries, power density, Energy density, Charging & Discharging cycle and recommended methodologies for charging. Recommended drives for EV and converter topology used in EVs						9
III	Energy Sources & Charging: Different Batteries and Ultra-capacitors, Battery characteristics (Discharging & Charging) Battery Chargers: Conductive (Basic charger circuits, microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication Methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and-charge zone.						9

IV	<p style="text-align: center;">EV Propulsion- Electric Motor:</p> <p>Choice of electric propulsion system, block diagram of EV propulsion system, concept of EV Motors, single motor and multi-motor configurations, fixed & variable geared transmission, In wheel motor configuration, classification of EV motors, Electric motors used in current vehicle applications, Recent EV Motors, Comparison of Electric Motors for EV applications.</p>	9
V	<p style="text-align: center;">Power Electronics & Control requirement for EV:</p> <p>Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, three-phase full bridge voltage-fed inverter, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance dc link inverter, Basics of Microcontroller & Control Strategies.</p>	9
VI	<p style="text-align: center;">EV Motor Drives:</p> <p>DC Motor: Type of wound-field DC Motor, Torque speed characteristics DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control.</p>	9
	Total	45

Text Books:

1. Dr. S. Sujatha, Senthil Kumar, 'A textbook on Electric vehicle technology' Scientific International Publishing House.
2. Stefano Longo Mehrdad Ehsani, Yimin Gao, 'Modern electric, Hybrid electric & fuel cell vehicles, Taylor & Fransis Exclusive.

Reference Books:

1. Amelie Ewert, Stephan Schmid, et al., 'Small Electric vehicles : An international view on light three and four wheeler, Springer publications
2. Ron Hodkinson & JohnFenton, Light Weight Electric/Hybrid Vehicle design, Butterworth Publications, Heinemann.
3. MarcedleKkeirn,H.A.Kiehne, 'BatteryTechnologyHandbook', Sandeep Dhameja, Electric vehicle battery systems, Butterworth-Heinemann

e-sources:

1. NPTEL :: [Electrical Engineering - NOC:Electric vehicles and Renewable energy](#) .

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester : II			
Course	Smart Healthcare IoT Systems			Code:	MET26PEC-555C		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
03	03	-	-	25	25	50	100

Pre-requisites: Embedded Systems and Analog Circuits

Course Outcomes: After completion of the course, the students will be able to:

CO1: Analyze strategic intent, stakeholder roles, and business performance using CSFs, KPIs, and KRAs supported by business analytics.

CO2: Evaluate external and internal environments using ETOP, Porter's Five Forces, VRIO, and Value Chain frameworks integrated with analytical modeling.

CO3: Develop strategic plans using portfolio models (BCG, GE), forecasting techniques, predictive analytics, and data-driven decision tools.

CO4: Apply strategic implementation frameworks (Mintzberg's 5Ps, McKinsey 7S, Six Sigma) and HR analytics to monitor and improve organizational performance.

CO5: Design sustainable, data-driven business strategies incorporating Balanced Scorecard, digital business models, AI-driven analytics, and ethical considerations.

Course Contents

Unit	Description	Duration [Hrs]
I	<p style="text-align: center;">Introduction to IoT in Smart Healthcare:</p> Evolution of smart healthcare using IoT, Future of IoT in Healthcare, Challenges in current healthcare systems, IoT healthcare services, Internet of Medical Things (IoMT), Components, Architecture of IoMT System, Benefits and impact of Internet of Medical Things (IoMT), Applications of IoMT, Big data in IoT, Wireless Body Area Networks (WBAN), Routing Protocols, Medium access control.	09
II	<p style="text-align: center;">Wearable Devices:</p> Bio-sensors: Introduction, Working Principle, Different Types of biosensors, Applications, Wearable Devices – Introduction, Evolution Portable devices, Attachable devices, Implantable and Ingestible devices.	09
III	<p style="text-align: center;">Data Aggregation Techniques:</p> Challenges in data aggregation in IoMT, Network Communications for health sensor data, Challenges of health care data sharing, health data aggregation techniques in IoT, design and implementation of interoperable IoT healthcare system..	09
IV	<p style="text-align: center;">Routing and Security:</p> Routing Protocols for IOT healthcare, Routing for intrabody communications, Routing for extra-body communications, MAEB Routing- QoS. Security and Privacy issues with IoT in healthcare, cyber security solutions for healthcare IoT, IoT discovery and Risk analysis, IoT policy management, IoT Threat Prevention.	09

V	IoMT Applications: Smart continuous glucose monitoring (CGM) and insulin pens, connected contact lenses, Connected inhalers, GPS Smart Sole, Remote Patient Monitoring, Efficient Drug Management, Medical Waste Management, IoT Heart Rate Monitoring, Epileptic Seizure Detection and Monitoring.	09
	Total	45
Text Books:		
<ol style="list-style-type: none"> 1. Krishna P. Venkata, Sasikumar Gurumoorthy, Mohammad S.Obaidat, Internet of Things and Personalized Healthcare Systems, Springer-2019. 2. Pattnaik, Prasant Kumar, Mohanty, Suneeta, Mohanty, Satarupa, Smart Healthcare Analytics in IoT Enabled Environment, Springer-2020. 3. Avijit Mathur, Thomas Newe, Walid Elgenaidi, Muzaffar Rao, Elfed Lewis and Daniel Toal, Medical IoT systems: architecture and security by Wearable Sensors, 2017. 4. Amit Banerjee, Lalit Garg, Joel J. P. C. Rodrigues –Internet of Medical Things for Smart Healthcare Springer Singapore, 2019 		
Reference Books:		
<ol style="list-style-type: none"> 1. Valentina Emilia Balas and Souvik Pal, Healthcare Paradigms in the Internet of Things Ecosystem, Academic Press, 2021. 2. Arshdeep Bhaga and Vijay Madiseti, Internet of Things: A Hands-on Approach, Universities Press, 2015. 3. Rajkumar Buyya and Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms . 		
e-sources:		
<ol style="list-style-type: none"> 1. Cloud computing By Prof. Soumya Kanti Ghosh, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs14/preview 2. Advanced Computer Networks, By Prof. Neminath Hubballi, Prof. Sameer G Kulkarni, https://onlinecourses.nptel.ac.in/noc25_cs02/preview 3. Cloud Computing and Distributed Systems By Prof. Rajiv Misra IIT Patna 		

Program	First Year M. Tech (All Programs) (Open Elective Course-I)			Semester : II			
Course	Strategic Management and Business Analytics			Code:	MCE260EC- 556A		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
03	03	-	-	25	25	50	100

Pre-requisites: Prior knowledge of Fundamentals of Management Principles is required.

Course Objectives: This course aims at enabling Students

1. To understand strategic management concepts, competitive positioning, and technology-driven business transformation.
2. To apply analytical frameworks and quantitative techniques for strategic decision-making.
3. To use business analytics tools for data-driven strategy formulation and performance evaluation.
4. To analyze digital business models, innovation ecosystems, and platform-based strategies.
5. To evaluate strategic risks, governance, and ethical implications of analytics-driven enterprises.

Course Outcomes: After completion of the course, the students will be able to:

- CO1: Analyze strategic intent, stakeholder roles, and business performance using CSFs, KPIs, and KRAs supported by business analytics.
- CO2: Evaluate external and internal environments using ETOP, Porter's Five Forces, VRIO, and Value Chain frameworks integrated with analytical modeling.
- CO3: Develop strategic plans using portfolio models (BCG, GE), forecasting techniques, predictive analytics, and data-driven decision tools.
- CO4: Apply strategic implementation frameworks (Mintzberg's 5Ps, McKinsey 7S, Six Sigma) and HR analytics to monitor and improve organizational performance.
- CO5: Design sustainable, data-driven business strategies incorporating Balanced Scorecard, digital business models, AI-driven analytics, and ethical considerations.

Course Contents

Unit	Description	Duration [Hrs]
I	<p style="text-align: center;">Foundations of Strategic Management</p> <p>Concept of strategy, Corporate, Business and Functional Levels of Strategy. Strategic Management Process- Phases; Stakeholder in Business and their Roles in Strategic management. Hierarchy of Strategic Intent; Business Definition, objectives and goals, Linking objectives to mission & vision. Critical success factors (CSF), Key Performance Indicators (KPI), Key Result Areas (KRA). Analytics: Business Analytics for KPIs such as People, Operations, Staregy e.g. Sales, Profit, ROI, operational efficiency, Revenue , total cost , employee turnover, capacity utilization, defect rate, on time delivery, time to market.</p>	09
II	<p style="text-align: center;">Formulating Strategy</p> <p>Analysing External Environment: Environmental Analysis (ETOP), Industry Analysis - Porter's Five Forces Model of competition, Entry & Exit Barriers, Strategic Group analysis. Analytics for Poter's five forces: Case or Cases which include - Statistical modeling to predict the likelihood of new</p>	09

	entrants based on various factors. Analysing Company's Environment: Resource-Based View- Examine a firm's resources and competitive position, introducing the VRIO Framework and benchmarking, Porter's Value Chain Analysis	
III	Strategic Planning: Portfolio Analysis Business Portfolio Analysis - BCG Matrix – GE 9 Cell Model, Generic Competitive and Grand Strategies: Analytics: Market trends, competitor strategies, and emerging opportunities, Strategic Insights for Managers, Forecasting, Business Simulations, Uncertainty estimations, Use Cases involving Predictive tools and Applications in solving problems using Marketing, Finance, M & A, Operations and Supply chain analytics, Competitive advantage through data-driven decisions. Cases and Applications in different sectors	09
IV	Strategic Implementation and Evaluation Structural, Functional Behavioural Implementation, Strategy, Mintzberg's 5 Ps – Deliberate & Emergent Strategies , Mc Kinsey's 7s Framework, Benchmarking, Six Sigma ,Analytics: Employee engagement and performance measurement, Case studies: Enhancing HR practices with analytics.	09
V	Introduction to Business Analytics Descriptive, Predictive, Prescriptive analytics, Data-driven decision-making, Data Warehousing and ETL concepts, Statistical tools for analytics: Regression, Time series analysis, Hypothesis testing, Introduction to Machine Learning for business applications	09
	Total	45

Text Books:

1. Strategic Management: Concepts and Cases- Fred R. David & Forest R. David

Reference Books:

1. The analytics revolution: how to improve your business by making analytics operational in the big data era, Bill Franks. Hoboken: Wiley
2. Statistical data analysis explained: applied environmental statistics with R, Clemens Reimann. Chichester: John Wiley and Sons
3. Data Analytics using R, Seema Acharya, TMGH

e-sources:

1. <https://www.youtube.com/watch?v=lzOFcVurWak>

e-Books:

1. https://www.phindia.com/Books/ShowBooks/MjY2/Business-Analysis-Analytics?srsltid=AfmBOoq96J6fynl5WHLK_fDUwl-HwFtXYXOOcbkID4F5EN9uxGmQmP_d

MOOC / NPTEL/YouTube Links:

1. <https://www.youtube.com/watch?v=67ZLG42Iwfk&list=PL3sk8amcDFDnzznNGtE0-BBt-fBgOkGVM>
2. <https://nptel.ac.in/courses/110107509>
3. https://onlinecourses.nptel.ac.in/noc26_cs64/preview

Program	First Year M. Tech (All Programs) (Open Elective Course-I)			Semester : II			
Course	Software Project Management			Code:	MCE260EC-556B		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100

Pre-requisites: Prior knowledge of Software Engineering, Basics of Project planning and management is required.

Course Objectives: This course aims at enabling Students

1. To understand core principles and practices of managing software projects.
2. To plan, estimate, schedule and control software development activities.
3. To identify and mitigate risks systematically.
4. To apply modern methods (Agile, iterative) along with classic planning techniques.
5. To analyze team, communication and stakeholder challenges in real work scenarios.

Course Outcomes: After completion of the course, the students will be able to:

- CO1: Understand foundational concepts and challenges in software project management.
CO2: Prepare project plans including estimation, schedules and budgets.
CO3: Apply risk, quality and resource management techniques to projects.
CO4: Use project control, change and configuration management frameworks.
CO5: Lead and communicate effectively in multidisciplinary software teams.

Course Contents

Unit	Description	Duration [Hrs]
I	<p style="text-align: center;">Project Concepts and Management</p> Project life cycle models-ISO 9001 model-Capability Maturity Model-Project Planning-Project tracking-Project closure. Evolution of Software Economics – Software Management Process Framework: Phases, Artifacts, Workflows, Checkpoints – Software Management Disciplines: Planning / Project Organization and Responsibilities / Automation / Project Control – Modern Project Profiles	09
II	<p style="text-align: center;">Cost Estimation and Agile Development</p> Problems in Software Estimation – Algorithmic Cost Estimation Process, Function Points, SLIM (Software Life cycle Management), COCOMO II (Constructive Cost Model) – Estimating Web Application Development – Concepts of Finance, Activity Based Costing and Economic Value Added (EVA) – Balanced Score Card. Agile methods, Agile development techniques, Extreme Programming, Various Agile Process Models – ASD, SCRUM, DSDM, Crystal, FDD, LSD, AM, AUP.	09
III	<p style="text-align: center;">Software Quality Management</p> Software Quality Factors – Software Quality Components – Software Quality Plan – Software Quality Metrics – Software Quality Costs – Software Quality Assurance Standard – Certification – Assessment. In Stream Activities in	09

	Project Management: Software Measurement Framework, Ishikawa's Seven tools, Process Assessment and patterns, CMMI – IPPD, Product and Process attributes, Software Quality and configuration management	
IV	Software Management and Metrics Software Configuration Management – Risk Management: Risk Assessment: Identification / Analysis / Prioritization – Risk Control: Planning / Resolution / Monitoring – Failure Mode and Effects Analysis (FMEA) – Defect Management – Cost Management. Software Metrics – Classification of Software Metrics: Product Metrics: Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality Metrics, and Process metrics.	09
V	Project Evaluation and Emerging Trends Strategic Assessment–Technical Assessment–Cost Benefit Analysis–Cash Flow Forecasting–Cost Benefit Evaluation Technique–Risk Evaluation–Software Effort Estimation. Emerging Trends in project management	09
	Total	45

Text Books:

1. Roger S. Pressman, Software Engineering: A practitioners approach, TMH , Seventh Edition, ISBN 978-0-07-337597-7 , ISBN 0-07-337597-7.
2. Ian Sommerville, Software Engineering, Addison-Wesley, Tenth Ed. ISBN-13: 978-0133943030 ISBN-10: 0133943038

Reference Books:

1. Linda I. Shafer, Robert T. Futrell, Donald F. Shafer, Quality Software Project Management, Prentice Hall, ISBN 0130912972.
2. Scott Berkun, The Art of Project Management, O'Reilly, First Edition, ISBN 0596007868.
3. Orit Hazzan and Yael Dubinsky, Agile software engineering, Springer –Verlag London, First Edition, ISBN 978-1-84800-199-2
4. Pankaj Jalote, Software Project Management in practice, Addison-Wesley Professional, ISBN 0201737213.
5. Craig Larman, Applying UML and Patterns, Pearson Education, Third Edition.
6. Grady Booch, James Rumbaugh, Ivar Jacobson, Unified Modeling Language Users Guide, Addison-Wesley, Second Edition, ISBN 0321267974.

e-sources:

1. https://books.google.mw/books?id=JUwQz2A_k_gC&printsec=frontcover#v=onepage&q&f=false

e-Books:

1. <https://www.amazon.in/Software-Project-Management-Chandramouli-Dutt-ebook/dp/B07YG4S9D9>

MOOC / NPTEL/YouTube Links:

1. <https://www.youtube.com/playlist?list=PLI0WdhayQoFC3JUXMzakqmst7I9W0Ljw>
2. <https://nptel.ac.in/courses/106105218>

Program	First Year M. Tech (All Programs) (Open Elective Course-I)			Semester: II			
Course	Cost management of engineering projects			Code:	MET260EC-556		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	UT	FA	SA	Total
3	3	-	-	25	25	50	100

Pre-requisites: None

Course Objectives: This course aims at enabling students:

6. To understand various cost concepts and their role in managerial decision-making.
7. To analyze project management processes including planning, execution, and control.
8. To apply cost behavior techniques and profit planning tools in real-world scenarios.
9. To evaluate modern cost management practices such as ABC, benchmarking, and budgeting.
10. To utilize quantitative techniques for optimizing cost and improving project efficiency..

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Apply cost concepts and costing systems for effective managerial decision-making.
CO2: Analyze and manage project execution, including cost estimation and control techniques.
CO3: Evaluate cost behavior and use profit planning tools for business decisions.
CO4: Implement advanced cost management methods like ABC, budgeting, and performance evaluation.
CO5: Apply quantitative techniques such as LP, PERT/CPM, and simulation for optimizing project costs.

	Description	Duration [Hrs.]
I	<p align="center">Fundamentals of Strategic Cost Management</p> <p>Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.</p>	9
II	<p align="center">Project Management and Cost Control</p> <p>Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre-project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process</p>	9
III	<p align="center">Cost Behavior and Profit Planning</p> <p>Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints</p>	9

IV	Advanced Cost Management Techniques Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing	9
V	Quantitative Techniques for Cost Optimization Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	9
	Total	45
Text Books & Reference Books:		
<ol style="list-style-type: none"> 1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi 2. Charles T. Horngren and George Foster, Advanced Management Accounting 3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting 		
Reference Books:		
<ol style="list-style-type: none"> 1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher 2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd 		
e-sources:		
<ol style="list-style-type: none"> 1. NPTEL – Management Accounting : https://nptel.ac.in/courses/110107127 2. NPTEL – Strategic Sourcing / Pricing Strategy: https://onlinecourses.nptel.ac.in/noc24_mg57/preview 		

Program	First Year M. Tech. E and TC Engineering (IoT and Sensor System)			Semester : II		
Course	Seminar I			Code:	SEM-581-IOT	
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks		
	Lecture	Practical	Tutorial	OR	TW	Total
2	-	4	-	25	25	50

Course Description -The seminar aims to enhance students' research, presentation, and critical thinking skills, preparing them for advanced academic pursuits and professional careers. Seminars will provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.

Course Objectives: This course aims at enabling students:

1. To enable students to explore a specialized topic within E&TC Engineering beyond the regular curriculum, fostering in-depth understanding.
2. To provide practical experience in identifying, acquiring, evaluating, and synthesizing information from various technical sources (research papers, standards, technical reports).
3. To cultivate effective oral and visual presentation skills, enabling students to articulate complex technical concepts clearly and concisely to a knowledge-able audience.
4. To encourage students to critically analyze existing research, identify challenges, propose solutions, and engage in constructive discussions.
5. To encourage self-directed learning and the ability to stay updated with emerging technologies and research trends.
6. To serve as a foundational step for the Master's thesis/dissertation, allowing students to explore potential research areas.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Formulate the goals and objectives of scientific research.
CO2: Search, evaluate and analyze information about the achievements of science and technology in the target area and beyond.
CO3: Interpret data from different fields of science and technology.
CO4: Build the logic of reasoning and statements.
CO5: Create, design and edit text documents in accordance with the requirements of the organization or publisher.

Guidelines

Category	Key Requirements & Details
Student Responsibilities	<ul style="list-style-type: none"> • Individual work only. • Weekly meetings with the guide. • Maintain a Project Diary (record of meetings/remarks). • Strictly adhere to ethical research and academic integrity.

Topic Selection	<ul style="list-style-type: none"> • Must be E&TC Engineering related (e.g., VLSI, AI/ML, IoT, 5G). • Focus on recent trends/developments (avoid basic textbook material). • Requires formal approval from the assigned supervisor.
Topic Proposal	<ul style="list-style-type: none"> • Timeline: 2–3 weeks after topic approval. • Content: Title, Abstract, Motivation, Scope, and 5–7 key references.
Research & Literature	<ul style="list-style-type: none"> • Sources: Peer-reviewed only (IEEE, ACM, Springer, Google Scholar). • Note: Wikipedia and unverified blogs are not acceptable. • Must include critical analysis of existing methodologies and gaps.
Seminar Report	<ul style="list-style-type: none"> • Timeline: Due 2–3 weeks before the presentation. • Length: 15–25 pages. • Format: Professional academic style (e.g., IEEE transaction style). • Sections: Abstract, Intro, Literature Review, Core Content, Analysis, Future Trends, and References.
Oral Presentation	<ul style="list-style-type: none"> • Duration: 25–30 mins presentation + 10–15 mins Q&A. • Visuals: Mandatory high-quality slides (PowerPoint/LaTeX Beamer). • Expectation: Clear articulation and ability to defend perspectives.

Text Books:

1. "Engineering Communication" by Charles W. Knisely & Karin I. Knisely
 2. "Technical Communication: Principles and Practice" by Meenakshi Raman & Sangeeta Sharma
- "The Craft of Scientific Presentations" by Michael Alley

e-sources:

1. <https://nptel.ac.in/courses/109/106/109106180/>
2. <https://www.udemy.com/course/technical-writing/>
3. <https://www.edx.org/course/writing-in-the-sciences>

Course Syllabus

Semester-III

Program	Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: III			
Course	Massive Open Online Course			Code	MET26SLC-601		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
4	-	-	-	100	-	-	100

Course Objectives: This course aims at enabling students:

1. To encourage independent learning through reputed MOOC platforms.
2. To develop expertise in emerging areas of Computer Engineering.
3. To enhance professional skills aligned with industry requirements.
4. To promote self-paced technical competency development.

Course Outcomes: After completion of the course, the students will be able to:

- C01: Analyze advanced concepts in the selected domain
C02: Apply learned techniques to solve practical problems.
C03: Demonstrate independent learning and certification competency.
C04: Present technical knowledge effectively through seminar and viva

Guidelines for Students:

1. Individual students need to register for MOOC course of their interest. Course must be **approved by Project Guide before registration.**
2. Week assignments need to be regularly completed as per requirement of course and to be submitted in file to Project Guide, which will be considered for internal assessment of course.
3. The certification of course is mandatory.
4. Oral and Presentation of course will be taken at the end of semester by Project Guide

Program	Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: III			
Course	INTERSHIP			Code:	MET26ELC-602		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
5	-	10	-	-	-	100	100

Pre-requisites: Basic knowledge

Course Objectives: This course aims at enabling students:

1. To put theory into practice. And expand thinking and broaden the knowledge and skills acquired through course work in the field.
2. To relate to, interact with, and learn from current professionals in the field.
3. To understand and adhere to professional standards in the field.
4. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
5. To develop the initiative and motivation to be a self-starter and work independently.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Gain practical experience within industry in which the internship is done..
CO2: Acquire knowledge of the industry in which the internship is done..
CO3: Apply knowledge and skills learned to classroom work
CO4: Develop and refine oral and written communication skills
CO5: Acquire the knowledge of administration, marketing, finance and economics..

Course Contents

	Description	Duration [Hrs.]
	<p>Course Description:</p> <ol style="list-style-type: none"> 1. Internship/On Job Training provide students the opportunity of hands-on experience that includes personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. 2. An internship is the phase of time for students when they are trained for their skills, they are good at, and it gives them a chance to apply their knowledge practically in industries 3. The internship can be carried out in any industry/R&D Organization/Research Institute/Institute of national repute/R&D Centre of Parent Institute. 4. The Department/college shall nominate a faculty to facilitate, guide and supervise students under internship. 	-
	Guidelines	
II	<ul style="list-style-type: none"> • Purpose: Internships are designed to bridge the gap between academic learning and industry practice. They aim to provide hands-on experience, expose students to the industrial environment, develop technical and soft skills (communication, teamwork, problem-solving), and help in career exploration. • Internship Duration and Academic Credentials 	--

– Student can take internship work in the form of Online/Offline mode from any of the Industry / Government Organization Internship Programmes approved by SPPU/AICTE/UGC portals

– A intern is expected to spend 10 - 12 hours per week on Internship, Training will result in about 160-170 hours of total internship duration.

– The minimum requirement regarding Internship duration should not be below 8 weeks

- **Type of Internship**

– Industry/Government Organization Internship: Working directly with a company or government body.

– Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.

– Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.

– Social Internship: Engaging in community-based projects.

- **Assessment Details (TW and Practical)**

- Term work for 100 marks

– A daily log submitted by the student and a work log signed by the office HoDs where the student has interned will be considered towards the TW marking.

- **Indicative list of areas for OJT**

--Trade and Agriculture

– Economy & Banking Financial Services and Insurance

– Logistics, Automotive & Capital Goods

– Fast Moving Consumer Goods & Retail

– Information Technology/Information Technology Enabled Services & Electronics

– Handcraft, Art, Design & Music

– Healthcare & Life Science

– Sports, Wellness and Physical Education

-Tourism & Hospitality

– Digitization & Emerging Technologies (Internet of Things / Artificial Intelligence / Machine

– Learning / Deep Learning / Augmented Reality / Virtual Reality etc.)

– Humanitarian, Public Policy and Legal Services

– Communication

– Education

– Sustainable Development

– Environment

– Commerce, Medium and Small-Scale Industries

- **Faculty Supervision:**

Students are usually assigned an internal faculty guide/mentor who supervises their internship activities. This faculty member acts as a teacher, mentor, and critic, and ensures the internship aligns with academic goals. External Supervision: In many cases, an external expert from the host organization also guides the student.

- **Documentation and Reporting:**

- Joining Report: To be submitted within a specified time frame (e.g., one week from joining).

- Daily/Periodical Diary: Students are often required to maintain a daily or weekly record of their observations, work, and learning.

- Internship Report: A comprehensive report detailing the work done, learning outcomes, and achievements during the internship. This report needs to be duly signed by the company official and faculty mentor.

- Completion Certificate: Issued by the host organization upon successful completion.

- **Evaluation:**

- Evaluation is typically done by the institute, often within a short period after the internship ends.

- It may involve presentations, viva-voce examinations, and assessment of the internship report and daily diary.

- Performance-based feedback from the industry mentor is usually a key component.

Program	Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: III			
Course	Seminar – II			Code:	MET26ELC-603		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
3	-	6	-	-	25	25	50

Course Objectives: This course aims at enabling students:

1. To provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.
2. To raise student's awareness in advanced methods of research and mastering the skills to apply them.
3. Teach students to find and critically analyze sources of information.
4. Develop their ability to build logic of reasoning and statements based on the interpretation of data combined from various fields of science and technology, to make judgments based on incomplete data.
5. Improve the student's academic writing experience.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: fundamental concepts and categories in the field of scientific research- ways of organizing and planning research.
CO2: relevant information sources that allow him or her to acquire new knowledge and skills in various fields.
CO3: advanced information technologies allowing us to acquire new knowledge in various fields.
CO4: features of the technical and scientific style of writing texts.
CO5: basic concepts of the culture of thinking, logic, rules for constructing reasoning and statements.
CO6: formal apparatus of the logic of constructing reasoning and statements
CO7: evaluation criteria and methods of handling incomplete data

By the end of the course, students will be able to:

- formulate the goals and objectives of scientific research;
- search, evaluate and analyze information about the achievements of science and technology in the target area and beyond;
- interpret data from different fields of science and technology;
- to build the logic of reasoning and statements;
- write a text in a scientific or scientific and technical style, use the appropriate vocabulary;
- create, design and edit text documents in accordance with the requirements of the organization or publisher;
- plan a pilot study
 - methods of planning scientific research, taking into account the peculiarities of the professional area.
 - methods of collecting and analyzing information on the achievements of science and technology in the target area and beyond.
 - proficiency in preparing publications on the topic of research
 - experience in data integration from different fields of science and technology and building evidence-based judgments.
 - methods of planning an experiment, taking into account the peculiarities of the field of professional activity.

Responsibility of the students:

The Seminar should be carried out individually by each student.

- A student should identify the area or topics in recent trends and developments in consultation with the guide
- A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
- A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay
- Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the project diary. The project diary must be presented during each review presentation to the reviewers.
- A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results
- A student should Incorporate constructive feedback to improve the quality and rigor of the research
- For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
- Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
- A student should invest time and effort in preparing for seminar presentations and the oral defense of the seminar

Course Contents

Unit	Seminars / Assignments	Duration [Hrs.]
	<ol style="list-style-type: none">1. Introductory lesson: clarification of the project topic, analysis of the assignment.2. The structure of scientific texts: abstract, article, presentation, research report, master's thesis.3. An analytical review on the research topic, its goals and objectives. Related works. Sources of information: open sources, journals, databases and collections of publishers. Citation rules. Scientific ethics. Plagiarism. Presentation and discussion of an in-depth analytical review on the research topic.4. Scientific novelty. Intellectual property. Patent search: goals and objectives, patent databases, rules for compiling a patent search report.5. Critical analysis of the related works. Identification and evaluation of methods used by other researchers. Choosing or developing your own method its rational.6. Research Design Stage: clarification of the requirements for the object being developed (soft- ware, hardware and software system, technical product).7. Formulation of criteria for the project goal achieving. Determination of ways to confirm the achievement of the set goal. Experimental study of the object under development.8. Experiment planning.	

	9. Preliminary report on the Research Project. Discussion of the preliminary results of the project. Recommendations for improvement and revision.	
	10. Final assessment: Project defense in the form of a presentation as seminar	

Text Books:

1. Kennett, B. (2014). Planning and managing scientific research. ANU Press. [https://www.jstor.org/stable/\(free access\)](https://www.jstor.org/stable/(free access))
2. Sirotinina, N. (2012). History and methodology of computer science. Siberian Federal University. Tomsk: TPU Publishing House.
3. Moore, N. (2006). How to do research: a practical guide to designing and managing research projects. Facet publishing

Program	Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: III			
Course	Research Project - I			Code	MET26ELC-604		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
9	-	18	-	-	25	25	50

Course Description:

The master's degree culminates in a research project of the student's own design. This research project is documented by a final research report or dissertation. The student's work is guided by an academic supervisor. Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc.

Students are expected to construct a research project that includes original research, deliberate and well considered methodological choices, and shows relevance to significant conversations within the discipline. The dissertation should represent the very best research and analysis a student can produce.

Course Objectives: This course aims at enabling students:

1. Demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
2. Demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project
3. Demonstrate expert knowledge in the subject of their research project, such as through a integrated literature survey
4. Demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions
5. Demonstrate the ability to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
6. Demonstrate an ability to relate their original data to existing literature, or to create an novel synthesis of existing materials
7. Demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument
8. Demonstrate an ability to balance description, analysis, and synthesis within their project report
9. Demonstrate an ability to reflect on the strengths and weaknesses of their research and method- ology, with constructive advice on how they might improve their efforts in future work

Course Outcomes: After learning the course, the students should be able to:

CO 1: Demonstrate how to search the existing literature to gather information about a specific problem or domain.

CO 2: Identify the state-of-the-art technologies and research in the chosen domain, and highlight open problems that are relevant to societal or industrial needs.

CO 3: Evaluate various solution techniques to determine the most feasible solution within given constraints for the chosen dissertation problem.

CO 4: Apply E&TC engineering principles related to requirements gathering and design to produce relevant documentation.

CO 5: Write a dissertation report that details the research problem, objectives, literature review, and solution architecture.

Guidelines: -

(a) The dissertation is a year-long project, conducted and evaluated in two phases. It can be carried out either in-house or within an industry as assigned by the department. The project topic and internal advisor (a faculty member from the department) are determined at the beginning of Phase I.

(b) Student is expected to complete the following activities in Phase-I:

- i. Literature survey
- ii. Problem Definition
- iii. Motivation for study and Objectives
- iv. Preliminary design / feasibility / modular approaches
- v. Design of the research project

Course Contents

Sl. No.	Suggested List of Experiments/Assignments
	Phase 1: Informal conversations
	Students are strongly encouraged to discuss possible research project ideas with the internal guide, fellow students, and other research professionals. All research projects begin with open-ended conversations and scoping exercises. These should be non-committal.
	Phase 2: Identify topic
	The first formal step in the module involves identifying a preliminary project title and writing an abstract of no more than 200 words. This requires submitting a completed registration form. Writing an abstract for a research proposal or for completed research work is an important transferable skill. Students who do not submit a completed registration form will be assigned a project. The project title is understood to be provisional. Supervisors will be assigned to students after the project title/ abstract

	<p>forms have been submitted. Supervision: A supervisor is required. The main responsibilities of the supervisor are to assist the student with project management and to advise the student on criteria for assessment. You can expect your supervisor to read and comment on a full draft of your research proposal and of your project.</p> <p>It is a good idea to discuss a time line for your project with your supervisor, and to establish a definite timetable.</p> <p>Some key points in our advice to students on compliance:</p> <ol style="list-style-type: none"> 1. allow at least two weeks between submitting an ethics application and the date of your first data collection 2. your supervisor must approve (and sign!) your ethics application before you submit it at departmental level 3. after your protocols have been approved, append a copy of your ethical approval certificate to the dissertation and project proposal.
	Phase 3: Project proposal.
	The proposal should reflect a student's best effort. At the same time, we recognize research often raises new questions. Some redefinitions of topics and titles is common later in the research process. Students should keep their supervisors up to date on these developments, and they can expect a reasonable amount of adaptation.
	Phase 4: Term-1 research
	<p>Students are expected to commit substantial time during the term to their research project. Supervisions The principal form of academic input for the research project normally comes through discussions with the designated supervisor. The majority of these meetings should be face-to-face, either in person or via video- or audio-conferencing technology.</p> <p>Students are expected to respect these periods of absence and plan their needs accordingly. One distinction is crucial:</p> <ol style="list-style-type: none"> (1) when staff are on leave, they are off work (i.e., not expected to maintain contact with their supervisees or to undertake their duties); however, (2) when staff are working remotely, they are at work (i.e., expected to maintain contact and to be available for normal duties). <p>A student's supervisor is not the only person who may advise on projects and writing. Others include peers and subject experts.</p>
	Phase 5: Submit project report
	The project report with the specific due date must be submitted to Department
	<p>Additional Information</p> <p>Research notebook : Students are strongly advised to maintain a research notebook, either digital or paper, and to keep this up to date. A research notebook can prove useful should examiners query research methods, research integrity, or research process.</p>

• **Preventing data loss:** Protect yourself against loss of research material and writing by maintaining a system for secure, redundant, up-to-date back-up of research material and writing. Loss cannot be accepted as a reason for failing to meet a deadline. A copy of written notebooks can be stored by supervisors for the duration of the project. Loss of project materials through accidents and theft have occurred in the past; these have had devastating effects on the un- 81prepared. All students are warned to create redundancies to protect their project from similar calamities.

• **Extensions :** This is a long-term research project, and time management is a learning objective. Short-term extensions normally are not considered. Applications for extension must be made through the processes described in the STS Student Handbook. Personal Tutors are the first point of contact on extension requests.

• **Word counts :** Words counted towards the total word count include the main body of the report and supporting footnotes or endnotes. The word count does not include: bibliography, front matter (title page, keywords, abstract, table of contents, acknowledgments), appendix material, supplemental data packages, table and figure legends, or documentation of ethics protocols or approvals. Otherwise, University standard policy on word counts will apply.

• **Re-using coursework from other modules :** Text and ideas in the research proposal may reappear in the dissertation if significantly developed or further elaborated; however, Universities policy on self-plagiarism prevents the same work receiving credit twice. This means rote duplication is not allowed.

• **Citation format :** The style must be clear, explicit, and meaningful. In every instance, it must allow an examiner to locate efficiently and specifically material referred to. As a recommendation, students should use a style frequently used in the literature relevant to their research project. Most journals have style guides in their notes to contributors. Students should dis- cuss options with their supervisors, and they should keep in mind that efficient citation is one element in the criteria for assessment.

Course Syllabus

Semester-IV

Program	Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: IV			
Course	Seminar - III			Code:	MET26ELC-651		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
4	-	8	-	50	-	50	100

Course Objectives: This course aims at enabling students:

1. To provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.
2. To raise student's awareness in advanced methods of research and mastering the skills to apply them.
3. To Teach students to find and critically analyze sources of information.
4. To Develop students ability to build logic of reasoning and statements based on the interpretation of data combined from various fields of science and technology, to make judgments based on incomplete data.
5. To Improve the student's academic writing experience.

Course Outcomes: After successful completion of the course, learner will be able to:

- CO1: Formulate the goals and objectives of scientific research.
CO2: Search, evaluate and analyze information about the achievements of science and technology in the target area and beyond.
CO3: Interpret data from different fields of science and technology.
CO4: To build the logic of reasoning and statements.
CO5: Write a text in a scientific or scientific and technical style, use the appropriate vocabulary.

Responsibility of the students

- The Seminar should be carried out individually by each student based on their research project
- A student should identify the area or topics in from the topic selected for research project related recent trends and developments in consultation with the guide
- A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
- A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
- Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the project diary. The project diary must be presented during each review presentation to the reviewers.
- A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results .
- A student should Incorporate constructive feedback to improve the quality and rigor of the research.

- For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
- Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
- A student should invest time and effort in preparing for seminar presentations and the oral defense of the seminar .

Learning Resources:

1. Kennett, B. (2014). Planning and managing scientific research. ANU Press.
[https://www.jstor.org/stable/\(free access\)](https://www.jstor.org/stable/(free access))
2. Moore, N. (2006). How to do research: a practical guide to designing and managing research projects. Facet publishing.

Program	Second Year M. Tech. E and TC Engineering (IoT and Sensor Systems)			Semester: IV			
Course	Research Project stage -II			Code	MET26ELC-652		
Credits	Teaching Scheme (Hrs./Week)			Examination Scheme and Marks			
	Lecture	Practical	Tutorial	PR	OR	TW	Total
18	-	36	-	-	50	150	200

Pre-requisites: Research Project Stage-I

Course Objectives: This course aims at enabling students:

1. **Demonstrate** an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
2. **Ability** to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
3. **Ability** to relate their original data to existing literature, or to create a novel synthesis of existing materials
4. **Identify and formulate** a problem of research interest in the chosen area of E&TC.

Course Outcomes: After learning the course, the students should be able to:

CO1: Undertake independent research that makes an original contribution to knowledge, or produces a novel synthesis of existing materials relevant to significant conversations in the discipline.

CO2: Plan their project in advance, using a proposal to describe their undertaking, describe how it will be managed, and reflect upon its value

CO3: Relate their original research to existing literature on the subject and relate their work to general themes in their relevant scholarly literature

CO4: Assemble their rationale, methods, findings, and analysis into a substantial piece of writing that presents a clear thesis and a cohesive evidence-based argument or analysis

CO5: Reflect on the strengths and weaknesses of their research and methodology, understanding how they might improve their efforts in future work

Guidelines for Research Project:

- ❖ The student shall consolidate and complete the remaining part of the research work started in Semester III. This will consist of Selection of Technology, Installations, implementations, testing, Results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions.
- ❖ The student shall prepare the duly certified final report of dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
- ❖ The students are expected to validate their study undertaken by publishing it at standard platforms.
- ❖ The investigations and findings need to be validated appropriately at standard platforms like conference and/or peer reviewed journal.

- ❖ The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination/Head of the department. The continuous assessment of the progress needs to be documented unambiguously.
- ❖ Supervisor Interaction: Minimum one meeting per week.
- ❖ Logbook: Maintain a record of work progress and supervisor comments.
- ❖ Ethics: No plagiarism, false results, or unethical practices allowed.
- ❖ Backup: Keep source code, datasets, and reports backed up securely.
- ❖ Submission Format: Soft copy (PDF) + Hard copy as per institute norms.

Key Components:

1. Implementation

- * Complete development/simulation/testing of the system or model.
- * Ensure correctness, efficiency, and validation of results.

2. Results & Analysis

- * Include experimental setup, datasets used, performance metrics.
- * Graphs, tables, and comparison with existing techniques.
- * Highlight key findings and their significance.

3. Conclusion and Future Work

- * Summarize outcomes, contributions, and applications.
- * Suggest extensions or improvements for future research.

4. Paper Publication

- * At least one paper (optional/encouraged) in peer-reviewed conference/journal.
- * Attach publication/proof as appendix (if available).

5. Final Report Format

- * Revised version of Stage 1 report with added implementation, results, and conclusion chapters.
- * Maintain academic writing standards and include all necessary references.

6. Plagiarism Report

- * Final version must again be checked and should not exceed 15% similarity.

7. Evaluation Parameters

- * Completeness and quality of implementation
- * Analysis and originality of results
- * Quality of documentation and adherence to format
- * Viv-voce performance and clarity of understanding
- * Contribution to knowledge or innovation