Semester- II

IoT Architecture and Protocol			
Course Code	MISS201	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	03

Course objectives: This Course will enable students to

- Understand the overview of IoT and its applications.
- Describe the IoT reference architecture and different types of architecture.
- Understand the various protocols and IoT based systems.

MODULE-1

Introduction to IOT, Applications of IOT, Use cases of IOT
(Text Book: 1) (RBT Levels: **L1, L2)**.

MODULE-2

The IoT Architectural Reference Model as Enabler, IoT in Practice: Examples: IoT in Logistics and Health

IoT Reference Model: Domain, information, functional and communication models.

Amazon Web Services for IoT: Amazon EC2, Amazon Auto Scaling, Amazon S3, Amazon RDS, Amazon DynamoDB, Amazon Kinesis, Amazon SQS, Amazon EMR, SkyNet IoT Messaging Platform.
(Text Book: 1) (RBT Levels: **L1, L2)**.

MODULE-3

IoT Reference Architecture: Architecture, Functional, information, deployment and operation views, SOA based Architecture, API-based Architecture, OPENIoT Architecture for IoT/Cloud Convergence.
(Text Book: 1) (RBT Levels: **L1, L2& L3)**.

MODULE-4

Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP. SCADA, Web Socket, IP-based Protocols: 6LoWPAN, RPL; Authentication Protocols; IEEE 802.15.4.
(Text Book: 2) (RBT Levels: **L1, L2& L3)**.

MODULE 5

Case study: Cloud-Based Smart-Facilities Management, Healthcare, Environment Monitoring System.
(Text Book: 3) (RBT Levels: **L1, L2& L3)**.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Execute Hello world in cooja Simulator
2	Study of 6LoWPAN protocol
3	Analysis of CoAP Mesh Network
4	Study of HTTP Protocol
5	Testing MQTT based IoT based Protocol or Experimental study of IoT based topologies on MQTT topologies
6	Simulation of Bluetooth Low Energy and Zigbee Smart Energy

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experiments shall be conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**..

SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to

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be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Text Books:

1. Bassi, Alessandro, et al, "Enabling things to talk", Springer-Verlag Berlin An, 2016.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
3. Vijay Madisetti and Arshdeep Bagha, "Internet of Things (A Hands-on- Approach)", 1st Edition, VPT, 2014.

Reference books:

1. Hersent, Olivier, David Boswarthick, and Omar Elloumi. "The internet of things: Key applications and protocols", John Wiley & Sons, 2011.
2. Bunya, Rajkumar, and Amir Vahid Dastjerdi, eds "Internet of Things:Principles and paradigms", Elsevier, 2016.

Web links and Video Lectures (e-Resources):

https://www.slideshare.net/slideshow/unit-vpdf-258200283/258200283

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Comprehend the essentials of IoT and its applications	L2
CO2	Explain the concepts of IoT Architecture Reference model and IoT Reference Architecture	L2
CO3	Analyse various IoT Application layer Protocols.	L3
CO4	Apply IP based protocols for IoT based systems.	L3

Principles of Sensors and Signal Conditioning			
Course Code	MISS202	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- Gain in depth knowledge about the principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
- Gain knowledge on data acquisition and signal conditioning.
- Understand the functionality of various types of sensors.

Module-1

Data Acquisition: Sensors, Signals, and Systems, Sensor Classification, Units of Measurements.
Sensor Characteristics: Sensors for Mobile Communication Devices, Span (Full-Scale Input), Full-Scale Output, Accuracy, Calibration Error, Hysteresis, Nonlinearity, Saturation, Repeatability, Dead Band, Resolution, Special Properties, Output Impedance, Output Format.
(Text Book: 1) (RBT Levels: **L1, L2& L3)**.

Module-2

Interface Electronic Circuits: Signal Conditioners, Sensor Connections, Excitation Circuits, Analog-to-Digital Converters.
(Text Book: 1) (RBT Levels: **L1, L2& L3)**.

Module-3

Temperature Sensors: Temperature References, Resistance Temperature Detectors (RTD),Ceramic Thermistors, Silicon and Germanium Thermistors, Semiconductor pn-Junction Temperature Sensors, Silicon PTC, Thermoelectric Sensors.
Humidity and Moisture Sensors: Concept of Humidity, Sensor Concepts, Capacitive Humidity Sensors, Resistive Humidity Sensors, Thermal Conductivity Sensor, Optical Hygrometers, Oscillating Hygrometer, Soil Moisture.
(Text Book: 1) (RBT Levels: **L1, L2 & L3)**.

Module-4

Detectors of Humans: Ultrasonic Detectors, Microwave Motion Detectors, Micro Power Impulse Radars, Ground Penetrating Radars, Linear Optical Sensors (PSD), Capacitive Occupancy Detectors, Triboelectric Detectors, Optoelectronic Motion Detectors, and Tactile Sensors.
(Text Book: 1) (RBT Levels: **L1, L2& L3)**.

Module-5

Pressure-Gradient Sensors: Pressure Sensors: Concept of Pressure, Units of Pressure, Mercury Pressure Sensor, Bellows, Membranes, and Thin Plates, Piezoresistive Sensors, Capacitive Sensors, Optoelectronic Pressure Sensors, Indirect Pressure Sensor.
Optical Temperature Sensors: Fluoroptic Sensors
Light Detectors: Introduction, Photodiode, Phototransistor, Photoresistor, Cooled Detectors, Imaging Sensors for Visible Range.
(Text Book: 1) (RBT Levels: **L1 & L2)**.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum mark. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.

Reference books:

1. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.
2. Gerd Keiser, "Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi.
3. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/playlist?list=PLkBAF6ag0X7r1l72hEUQDcwq_DhsIw8Bt.

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Explain the principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.	L3
CO2	Explain data acquisition and signal conditioning concepts.	L3
CO3	Explain the functionality of various types of sensors	L3

IoT Applications			
Course Code	MISS203	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- Understand IoT concepts and network architecture for practical application.
- Understand roles in IoT, simplified architecture, and computing hierarchy.
- Understand smart objects, sensor networks, and IoT access technologies.
- Gain knowledge about IoT application protocols, data analytics, and big data technologies.
- Understand IoT security strategies and best practices.

Module-1

What is IoT: Introduction to IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and OT , IoT Challenges

IoT Network Architecture and Design: Drivers Behind New Network Architectures, Comparing IoT Architectures

(Text Book:1, RBT Levels: L1 & L2)

Module-2

Simplified IoT Architecture: The Core IoT Functional Stack, Layer1, Layer 2, Layer3.

IoT Data Management and Compute Stack: Fog Computing, Edge Computing, The Hierarchy of Edge, Fog and Cloud.

(Text Book:1, RBT Levels: L1 & L2)

Module-3

Smart Objects: The "Things" in IoT: Sensors, Actuators and Smart Objects, Micro-Electro-Mechanical Systems (MEMS), Smart Objects, Sensor Networks.

Connecting Smart Objects: Communications Criteria, Range, Frequency Bands, Power Consumption, Topology, Constrained Devices, Constrained- Node Networks, Data Rate and Throughput, Latency and Determinism, Overhead and Payload.

IoT Access Technologies: IEEE 802.15.4, Standardization and Alliances, Physical Layer, MAC Layer, Topology, Security, Competitive Technologies, IEEE802.15.4g and 802.15.4e, Standardization and Alliances, Physical Layer, MAC Layer, Topology, Security, Competitive Technologies.

(Text Book:1, RBT Levels: L1 & L2)

Module-4

Application Protocols for IoT: The Transport Layer, IoT Application Transport Methods, Application Layer Protocol Not Present, SCADA, A Little Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T, Generic Web-Based Protocols.

Data and Analytics for IoT: An introduction to Data Analytics for IoT, Big Data Analytics Tools and Technology, Edge Streaming Analytics

(Text Book:1, RBT Levels: L1 & L2)

Module-5

Securing IoT: A Brief History of IoT Security, Common Challenges in IoT Security, How IoT Security Practices and Systems Vary, Formal Risk Analysis Structures, The Phased Application of Security in an Operational Environment.

(Text Book:1, RBT Levels: L1 & L2)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum mark. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. David Hanes , Gonzalo Salgueiro, Patrick Grossetete , Robert Barton , Jerome Henry "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things".

Reference books:

1. Arshdeep Bhaga, Vijay Madishetti, "Internet of things: A hands on Approach", Universities Press, ISBN:978172719547, 2015.

Web links and Video Lectures (e-Resources):

https://youtu.be/c6lqXb14c0I

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Explain IoT concepts and network architecture for practical application.	L2
CO2	Analyse roles in IoT, apply simplified architecture and computing hierarchy.	L2
CO3	Analyse smart objects, sensor networks, and IoT access technologies.	L2
CO4	Analyze and apply IoT application protocols, data analytics, and big data technologies.	L2
CO5	Explain IoT security strategies and apply best practices effectively.	L2

Cloud Computing			
Course Code	MISS204	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- Understand the basic concepts of cloud computing, delivery models and deployment models.
- Understand the cloud-enabling technologies, virtualization, web, multitenant, and service technologies.
- Understand cloud infrastructure mechanisms and fundamental cloud architectures.
- Understand advanced cloud architectures.
- Gain knowledge on cloud management mechanisms, fundamental cloud security concepts and security mechanism.

Module-1

Understanding Cloud Computing: Origins and Influences, A Brief History, Definitions, Business Drivers, Technology Innovations, Basic Concepts and Terminology, Goals and Benefits, Reduced Investments and Proportional Costs, Increased Scalability, Increased Scalability, Risks and Challenges,
Fundamental Concepts and Models: Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Comparing Cloud Delivery Models, Other Cloud Deployment Models.
(RBT Levels: L1 & L2)

Module-2

Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Internet Service Providers (ISPs), Connectionless Packet Switching (Datagram Networks), Router-Based Interconnectivity, Technical and Business Considerations, Data Center Technology, Virtualization, Standardization and Modularity, Remote Operation and Management, High Availability, Security-Aware Design, Operation, and Management, Facilities, Computing Hardware, Storage Hardware.
Virtualization Technology, Web Technology, Multitenant Technology, Service Technology, Web Services, Case Study Example.
(RBT Levels: L1 & L2)

Module-3

Cloud Infrastructure Mechanisms: Logical Network Perimeter, Case Study Example, Virtual Server, Case Study Example, Cloud Storage Device, Cloud Storage Levels, Network Storage Interfaces, Object Storage Interfaces, Database Storage Interfaces, Cloud Usage Monitor, Resource Replication, Case Study Example.
Fundamental Cloud Architectures: Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example.
(RBT Levels: L1 & L2)

Module-4

Advanced Cloud Architectures: Hypervisor Clustering Architecture, Load Balanced Virtual Server Instances Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime Architecture, Cloud Balancing Architecture, Resource Reservation Architecture, Dynamic Failure Detection and Recovery Architecture, Bare-Metal Provisioning Architecture, Rapid Provisioning Architecture, Storage Workload Management Architecture, Case Study Example.
(RBT Levels: L1 & L2)

Module-5

Cloud Management Mechanisms: Remote Administration System, Resource Management System, SLA Management System, Billing Management System.

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Fundamental Cloud Security: Basic Terms and Concepts, Threat Agents, Cloud Security Threats, Additional Considerations, Case Study Example

Cloud Security Mechanisms: Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On(SSO), Cloud-Based Security Groups, Hardened Virtual Server Images

(RBT Levels: L1 & L2)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Cloud computing concepts, Technology and Architecture – Thomas Erl, Zaigham Mahmood, Ricardo Puttini , Pearson , 2017.

Reference books:

1. Instant Guide to Cloud Computing, Anand Nayar (Ed), Ashokkumar, sudeepTanwar, BPB, 2019.
2. Cloud computing a practical approach - Anthony T.Velte, Toby J. Velte Robert Elsenpeter TATA McGraw - Hill, New Delhi – 2010.
3. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley India, 2010.

Web links and Video Lectures (e-Resources):

- https://noc19-ee28 lec08 RFID based localization – I
- https://youtu.be/6nFwWp6iJvs

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Explain cloud computing concepts, delivery models, and deployment models.	L2
CO2	Explain cloud-enabling technologies like virtualization, web services, multitenancy, and service technologies.	L2
CO3	Explain cloud infrastructure mechanisms and fundamental cloud architectures.	L2
CO4	Explain advanced cloud architectures to optimize performance and scalability.	L2
CO5	Apply cloud management mechanisms and fundamental cloud security concepts and mechanisms to safeguard cloud environments effectively.	L3

IoT and Sensor Systems Lab			
Course Code	MISSL207	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:4:0	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives: This Course will enable students to

- Understand necessary and practical knowledge about the components of IoT
- Gain skills required to build real-life IoT based projects.

Sl.NO	Experiments
1	Familiarization with the concept of IoT, Raspberry Pi /Arduino and perform necessary software installation.
2	Study of different operating systems for Raspberry Pi and Understanding the process of OS installation on Raspberry – Pi.
3	Interfacing Raspberry-Pi/ Arduino with basic peripherals.
4	Interfacing Raspberry-Pi / Arduino with temperature sensor and LED array.
5	Interfacing Raspberry-Pi/ Arduino with IR and ultrasonic sensors.
6	Interfacing Raspberry-Pi/ Arduino with PiCam.
7	Study of connectivity of Raspberry-Pi/ Arduino circuit to control the operation of a stepper motor.
8	Setup a cloud platform to log data using Raspberry PI/ Arduino and upload to the cloud platform.
9	Design an IoT based system for Medical/Industrial/Agricultural applications.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Develop solutions to address the real time applications.
- Develop program using Arduino and Raspberry-Pi module with the integration of various peripherals for real time applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.

In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the **rest** 40% for viva-voce.

- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marks is scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours.

Professional Elective-III

Microcontrollers for IoT			
Course Code	MISS215A	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- Understand low power microcontrollers and develop the programming skills for low power applications.
- Gain the knowledge of various peripheral related to sensing and communication using wired or wireless means.
- Develop the skill set to build IoT Systems.

Module-1

Introduction: Embedded system, Microcontrollers vs Microprocessor, Anatomy of a Microcontroller.
MSP430 Microcontrollers: Functional Block diagram, Memory, CPU, addressing modes, Constant Generator and Emulated Instructions, Instruction Set, Examples, Reflections on the CPU and Instruction Set, Exceptions: interrupt and Resets, Clock system.
(RBT Levels: L2&L3).

Module-2

Development: Development Environment, Access to the Microcontroller for Programming and Debugging, Demonstration Boards, Examples: Light LEDs in C, Read Input from a Switch. Functions, Interrupts, and Low-Power Modes.
Functions and Subroutines, Interrupts, ISR, Low-Power Modes of Operation.
(RBT Levels: L2 &L3).

Module-3

ARM7 LPC2148 Introduction, RISC features, ARM programmers' model, Peripherals, Memory mapping for data, code and peripherals, pin configuration, pin connect block, GPIO Peripheral, Nested vectored interrupt controller in LPC2148, Interrupts in LPC2148
(RBT Levels: L2 &L3).

Module-4

UART protocol and its implementation in LPC2148, SPI protocol and its implementation in LPC2148, I2C protocol and its implementation in LPC2148.
(RBT Levels: L2 &L3).

Module-5

ADC, DAC and RTC in LPC2148, Timer in LPC2148 and its various modes of operations
Sensors interfacing: Sensors interfacing techniques-Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11.
Cloud interfacing: Interfacing and data logging with cloud
(RBT Levels: L2 &L3).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. John H. Davies, "MSP430 Microcontroller Basics", 2011, 2nd ed.,Newnes publishing, New York
2. Prof Steve Furber , "ARM System on Chip architecture", Addison Wesley; 2 edition (17 August 2000) .
3. UM10139 – lpc214x User manual

Reference books:

1. Muhammad Ali Mazidi, Shujen Chen, SarmadNaimi, SepehrNaimi,"TI ARM Peripherals Programming and Interfacing: Using C Language", 2015, 2nd ed., Mazidi and Naimi publishing, New York.
2. Sergey Y. Yurish,"Digital Sensors and Sensor Systems: Practical Design", 2011, 1st ed., IFSA publishing, New York
3. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2014, 4th ed., Springer, New York.

Web links and Video Lectures (e-Resources):

- https://www.nxp.com/docs/en/data-sheet/LPC2141_42_44_46_48.pdf
- https://www.youtube.com/watch?v=7LqPJGnBPMM

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Explain the architecture and instruction set of microcontrollers.	L2
CO2	Develop programs using on chip features of microcontrollers.	L3
CO3	Develop sensor interfacing programs.	L3

Wireless Sensor Network			
Course Code	MISS215B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- Understand basic sensor network concepts.
- Understand the physical layer issues and analyse Medium Access Control Protocols.
- Comprehend network and transport layer characteristics and protocols.
- Understand the network management and Middleware services.

Module-1

Introduction: Challenges for wireless sensor networks, Comparison of sensor network withadhoc network,
Single node architecture: Hardware components, Energy consumption of sensor nodes.
Network architecture: Sensor network scenarios, Optimization Goals.
(RBT Levels: L1 &L2).

Module-2

Design principles for WSNs, Gateway concepts.
Physical Layer: Physical layer and transceiver design consideration in wireless sensor networks.
(RBT Levels: L1 & L2).

Module-3

MAC protocols: Fundamentals of wireless MAC protocols, Low duty cycle protocols and wakeup concepts, Contention-based protocols, Schedule-based protocols.
Routing Protocols : Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, Geographic routing,
Data-centric and content-based networking: Data centric routing, Data aggregation.
(RBT Levels: L1 &L2).

Module-4

Localization and positioning: Possible approaches3, Single hop localization, Positioning in multi-hop environments.
Time synchronization: Introduction to the time synchronization problem, Protocols based on sender/ receiver, Protocols based on receiver /receiver synchronization in WSN.
(RBT Levels: L1 & L2).

Module-5

Programming Challenges in Wireless Sensor Networks, Contiki OS, Event-Driven Programming, Techniques for Protocol Programming.
(RBT Levels: L1, L2& L3).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" 2011, 1st ed., John Wiley & Sons, New Jersey.
2. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks: an Information Processing Approach", Elsevier Publication, 2004.

Reference books:

1. Fei Hu and Xiaojun Cao, "Wireless Sensor Networks Principles and Practice", CRC Press,2010.
2. TinyOS Programming Paperback – Illustrated, 12 March 2009
3. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
4. Sitharama Iyengar S, Nandan Parmeshwaran, Balkrishnan N and Chuka D, "Fundamentals of Sensor Network Programming, Applications and Technology", John Wiley & Sons, 2011.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ycaz99NogS4

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Explain the basics concepts of Wireless Sensor Network architecture and its principles.	L2
CO2	Explain the physical layer issues.	L2
CO3	Explain the MAC and Network layer Routing Protocol.	L2
CO4	Apply the concepts of localization and time synchronization.	L3
CO5	Apply programming concept for the implementation of WSN.	L3

Flexible and Wearable Sensors			
Course Code	**MISS215C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- To provide the overview of flexible electronics technology and the issues with materials processing for thin film electronics.
- To expose the students for the materials selection and patterning methods for thin film electronics development.
- To describe the process involved in transferring the flexible electronics from foils to textiles and also the challenges, opportunities and the future of wearable devices.
- To expose the students to the design, challenges of wearable sensors employed for sensing the physical and biological parameters and the process involved in the conversion of conducting and semiconducting fibers to smart textiles.

Module-1

Overview of flexible electronics technology: History of flexible electronics - Materials for flexible electronics: degrees of flexiblility, substrates, backplane electronics, front plane technologies, encapsulation - Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-to-Roll processing - Additive printing.

Amorphous and nano-crystalline silicon materials and Thin film transistors

Fundamental issues for low temperature processing - low temperature amorphous and nano- crystalline silicon - characteristics of low temperature dielectric thin film deposition - low temperature silicon nitride and silicon oxide characteristics - Device structures and materials processing - Device performance - Contacts for the device - Device stability.

(RBT Levels: L1 & L2).

Module-2

Materials and Novel patterning methods for flexible electronics

Materials considerations for flexible electronics: Overview, Inorganics semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing active materials.

(RBT Levels: L1 & L2).

Module-3

Flexible electronics from foils to textiles

Introduction -Thin film transistors: Materials and Technologies - Review of semiconductors employed in flexible electronics - Thin film transistors based on IGZO - Plastic electronics for smart textiles - Improvements and limitations.

(RBT Levels: L1 & L2).

Module-4

Wearable haptics: World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunities - Future of wearables - Need for wearable haptic devices -Categories of wearable haptic and tactile display.

Wearable Bio, Chemical and Inertial sensors: Introduction-Systems design - Challenges in chemical and biochemical sensing - Application areas

Wearable inertial sensors - obtained parameters from inertial sensors - Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Application in clinical practice and future scope.

(RBT Levels: L1 & L2).

Module-5
Knitted electronic textiles: From fibers to textile sensors - Interlaced network -Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors and other applications. FBG sensor in Intelligent Clothing and Biomechanics. (RBT Levels: L1 & L2).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, "Sensor Technologies: Healthcare, Wellness and Environmental Applications", 201, 1st Edition , Apress Media LLC, New York.
2. Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, 1st Edition, Academic Press, Cambridge.

Reference books:

1. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York.
2. Kate Hartman, "Make: Wearable Electronics: Design, prototype, and wear your own interactive garments", 2014, 1st Edition, Marker Media, Netherlands.
3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1st Edition, World Scientific Publishing Co, Singapore.
4. Yugang Sun, John A. Rogers, "Semiconductor Nanomaterials for Flexible Technologies: from Photovoltaics and Electronics to Sensors and Energy Storage (Micro and NanoTechnologies)", 2011, 1st Edition, William Andrew, New York.

Web links and Video Lectures (e-Resources):

- https://10.1016/b978-0-12-418662-0.00020-9
- https://10.1016/b978-0-12-418662-0.00025-8
- https://10.1016/b978-0-12-418662-0.00003-9

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description
CO1	Realize the technology developments in the flexible electronics technology.
CO2	Ability to identify the suitable materials and its processing for the development of thin film electronics.
CO3	Ability to design the pattern and develop with suitable patterning methods.
CO4	Realize the process involved in the transformation of electronics from foils to textiles.
CO5	Acquire the design knowledge for developing wearable sensors for physical and chemical parameters.
CO6	Gain the competency in transferring the conducting and semiconducting fibers to smart textiles

MOBILE APP DEVELOPMENT WITH ANDROID			
Course Code	**MISS215D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This Course will enable students to

- Discuss major building blocks of an android application
- Write android applications using various UI components and data handling using SQ LiIte
- Discuss advanced topics such as LBS, Mapping, Network connectivity, background threads, adapters

Module-1

Introduction: Introduction to Android and Eclipse environment, Android application framework, Unique aspects of mobile application, Why develop for Android, What has and will continue to drive Android adoption.
(RBT Levels: **L1 & L2)**.

Module-2

Android building blocks: Android manifest file, Dalvik virtual machine, DDMS, ADT, Adb, Android emulator, Activities and intents, creating a project, Android activity lifecycle, starting a new 'Hello World' Android application, Running and Debugging applications.
(RBT Levels: **L1 & L2)**.

Module-3

Android Screen Screen UI Components: Layouts Linear Layout, Absolute Layout, Table Layout, Relative Layout, Frame Layout, Scroll View, Views: Text View, Edit Text, and Button views, Time Picker and Date Picker views, List View and the Spinner views, Gallery and Image Switcher views, context sensitive menu.
(RBT Levels: **L1 & L2)**.

Module-4

Data management with SQLite: SQLite architecture, creating and using databases, DBAdapter class, Common SQLite commands, creating triggers, logging insert, delete, update using SQLite, managing persistent data.
(RBT Levels: **L1 & L2)**.

Module-5

Advanced topics: Adapters, background threads, Notifications, Location based services, Mapping, network connectivity services, telephony services.
(RBT Levels: **L1 & L2)**.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Web links and Video Lectures (e-Resources):

- https://youtu.be/-foyVzTOf8o.

Suggested Learning Resources:

Text Books

1. Lauren Darcey and Shane Conder, "Sams Teach Yourself Android Application Development in 24 Hours", Sams Publishing, First Edition, ISBN-10: 0321673352, ISBN-13: 978-0321673350, 2010.
2. Ed Burnette, "Hello, Android: Introducing Google'
3. Mobile Development Platform", Pragamatic, Third Edition, ISBN-10: 1934356565, ISBN-13: 978-1934356562, 2011.
4. Rick Rogers and John Lombardo, "Android Application Development: Programming", O'Reilly Media, First Edition, ISBN-10: 0596521472 , ISBN-13: 978-0596521479 , 2009.
5. Reto Meier , "Professional Android 2 Application Development (Wrox Programmer to Programmer)", Wrox, Second Edition, ISBN-10: 0470565527, ISBN-13: 978-0470565520, 2010.

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description
CO1	Explain android architecture and framework
CO2	Discuss major building blocks of an android application
CO3	Write android applications using various UI components and data handling using SQLiIte
CO4	Discuss advanced topics such as LBS, Mapping, Network connectivity, background threads, adapters

Professional Elective-IV

OPERATING SYSTEM FOR IOT			
Course Code	**MISS216A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students to

- Understand the fundaments of OS, process creation and multi thread concepts.
- Understand the process-scheduling algorithms and process synchronization concepts on various scenarios.
- Understand the process of memory management techniques and Time management handled by operating system.
- Understand the concept of event driven on tiny OS and Contiki.

Module-1

Introduction to Operating Systems: OS vs RTOS, Functions of Operating Systems, Introduction to Kernel, Types of Kernels, User space vs Kernel Space.

Process Management: The process concept, synchronization, mutual exclusion, semaphores, and monitors, Threads, Inter-process communication Data Aggregation and Group Operations Case study: Exploratory analysis of public / scrapped datasets.
(RBT Levels: **L1 & L2)**.

Module-2

Resource Allocation, Deadlock prevention, avoidance, and detection.

The OS Kernel, Micro and Monolithic kernels, multi-tasking, privilege, interrupt handling, System and user processes, System calls.
(RBT Levels: **L1 & L2)**.

Module-3

Memory Management: Description of problems of allocation, protection and sharing, Virtual to Physical memory mapping schemes, segmented paged virtual memory, paging control, replacement algorithms, the working set model, Sharing code and data.
(RBT Levels: **L1 & L2)**.

Module-4

Time Management: Time Management, CPU scheduling algorithms, Real-time scheduling, Disc access scheduling.
(RBT Levels: **L1 & L2)**.

Module-5

Real Time OS: Real Time OS, OS calls in RTOS, RTx Kernel OS calls – Examples

Real Time Systems: Operating systems for IoT, Pre-emption vs Event Driven, Event Driven Programming, Tiny OS vs Contiki.
(RBT Levels: **L1 & L2)**.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Abraham Silberschatz, Peter Galvin, Grag Gagne, "Operating System principles", Seventh Edition, John Wiley Publications, 2006.
2. Allan Burns, Andy Wellings, "Real – Time Systems and Programming Languages", Fourth Edition, Pearson Education Canada, 2009.
3. Milan Milenkovic, "Operating Stems Concepts and Design", McGraw Hill Higher Education, 1987.
4. Maurice Bach (IPC), "Design of Unix Operating System", Prentice-Hall, Inc., 1986.
5. www.freertos.org, "The Free RTOS Reference Manual", Real Time Engineers Ltd. 2016

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description
CO1	Illustrate OS fundamentals, process creation, process hierarchies and multi-thread concepts
CO2	Apply process-scheduling algorithms and process synchronization concepts on various scenarios.
CO3	Analyse the memory management techniques handled by operating system.
CO4	Identify the salient features of real time operating systems with programming on RTx.
CO5	Infer the concept of event driven programming on tiny OS and Contiki

RADIO FREQUENCY AND MICROWAVE SENSORS			
Course Code	**MISS216B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives: This Course will enable students to

- To introduce the students with different RF and Microwave sensors.
- To familiarize antenna design with a good understanding of their parameters and applications.
- To introduce the concepts of RADAR and its Application.
- To introduce comprehensive knowledge of wearable antenna.
- To understand basics of different microwave sensors.

Module-1

RF Sensors Microwave Antenna-Introduction, types of Antenna, fundamental parameters of antennas, radiation mechanism, Fresnel and Fraunhofer regions. Antenna for communication and Antenna for sensing, radiometer and radar
(RBT Levels: **L1 & L2)**..

Module-2

Antenna for personal area communication: Concepts of Printed Antennas, Broadband Microstrip Patch Antennas, Antennas for Wearable Devices, Design Requirements, Modeling and Characterization of Wearable Antennas, WBAN Radio Channel Characterization and Effect of Wearable Antennas, Domains of Operation, Sources on the Human Body, Compact Wearable Antenna for different applications.
(RBT Levels: **L1 & L2)**..

Module-3

Radar Introduction to RADAR, RADAR range equation, MTI and pulse Doppler RADAR, Tracking RADAR, SAR pulse RADAR, CW RADAR. Applications of Radar Automotive, remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of RADAR, RADAR transmitters, Receivers.
(RBT Levels: **L1 & L2)**..

Module-4

Radiometers Radiative transfer theory, SMMR, Types of radiometers - and Bolometers, Applications in automotive, agriculture, medicine and weather forecasting.
(RBT Levels: **L1 & L2)**..

Module-5

Microwave power Sensors Diode: Diode detector principles, dynamic range average power sensors, signal waveform effects on the measurement uncertainty of diode sensors. Thermocouple Sensors: Principles of Thermocouple sensor, power meters for thermocouple sensors.
(RBT Levels: **L1 & L2)**.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. Balanis Constantine A. (2016): "Antenna Theory Analysis and Design" , 4th Edition, New Jersey: John Wiley and Sons.
2. Peter S Hall, Yang Hao , "Antenna and Propagation for Body Centric Wireless Communications",Second Edition , Artech House.
3. Shiban Kishan Koul, Richa Bharadwaj , "Wearable Antennas and Body Centric Communication", Springer Lecture Notes in Electrical Engineering
4. Merrill I Skolnik ,"Introduction to Radar Systems "Tata McGraw-Hill.
5. Niels Skou, D. M. Le Vine," Microwave Radiometer Systems Design and Analysis " Artech House.

Web links and Video Lectures (e-Resources):

- https://youtu.be/c6lqXb14c0I

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description
CO1	Select a proper antenna design to be used in the RF spectral region.
CO2	Apply the basic knowledge in the measurement of RF radiation.
CO3	Understand about the RADAR and It's application.
CO4	Correlate the principle behind different radar systems and determine various applications based on the radar systems.
CO5	Interpret about the power sensor and diode sensor.

PRIVACY AND SECURITY IN IOT			
Course Code	**MISS216C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To know the state-of-the-art methodologies in Cyber Physical system.
- To impart knowledge on Model threats and countermeasures.
- To explore the Privacy Preservation and Trust Models in Internet of Things (IoT).
- To apply the concept of Internet of Things Security in the real world scenarios

Module-1

Introduction to IoT –Cyber Physical Systems: IoT and cyber-physical systems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle.
(RBT Levels: L1 & L2).

Module-2

IoT as Interconnection of Threats : Network Robustness of Internet of Things- Sybil Attack Detection in Vehicular Networks- Malware Propagation and Control in Internet of Things- Solution-Based Analysis of Attack Vectors on Smart Home Systems.

Module-3

Cryptographic Fundamentals: Encryption and Decryption, Hashes, Digital Signature, Cryptographic module principles, key management fundamentals, IoT communication protocols like blutooth, zigbee, Near field Communication (NFC), IoT Messaging protocols like MQTT, CoAP, DDS, REST.
(RBT Levels: L1 & L2).

Module-4

Block Chains : Block chain basics, blockchain nodes, blockchain P2P network, alticoins, Ethereum wallets and smart contracts, hyper ledger.
(RBT Levels: L1 & L2).

Module-5

Privacy Preservation for IoT : Privacy Preservation Data Dissemination- Privacy Preservation Data Dissemination- Social Features for Location Privacy Enhancement in Internet of Vehicles- Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing.
(RBT Levels: L1 & L2).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Hu Fei. (2016) ; **Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations**, 1st edition, CRC Press.
2. Russell, Brian, Van Duren Drew (2016) : **Practical Internet of Things Security**, 1st edition, Packt Publishing Ltd.
3. The Blockchain Developer, Elad Elrom, ISBN:13(pbk):978-1-4842-4846-1.

Reference Books

1. Whitehouse O. (2014): **Security of things: An implementers' guide to cyber-security for internet of things devices and beyond**, 1st edition, NCC Group.
2. DaCosta, Francis, Henderson Byron (2013): **Rethinking the Internet of Things: a scalable approach to connecting everything**, 1st edition, Springer Nature.

Web links and Video Lectures (e-Resources):

- https://youtu.be/4C4P_tzjthc

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description
CO1	Understand the cryptographic fundamentals for IoT
CO2	Demonstrate the Security requirements in IoT.
CO3	Apply the authentication credentials and access control
CO4	Relate the Block Chains for IoT.
CO5	Analyze the security principles and methodologies for Internet of Things

AZURE IOT DEVELOPMENT			
Course Code	**MISS216D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- Understanding Azure IoT Platform, Learning different Device Management operaations, commands
- Learning Azure IoT Communication protocols, best practices to secure Azure IoT Hub and Pre-Configured solutions analytics.
- Connect and implementing Azure IoT using real devices.

Module-1

Azure IoT platform:
Introduction, creating Azure IoT Hub from the portal, Command Prompt, PowerShell, Understanding the Azure IoT Suite, using Azure IoT SDK, Calculating the pricing of IoT Hub.
Introducing Device Management: Introduction, Device registry operations, Device twins, Device direct methods, Device jobs, IoT Hub query explorer
(RBT Levels: L1 & L2).

Module-2

IoT Hub Messaging and Commands:
Introduction, Messaging device-to-cloud, Processing device-to-cloud messaging, Messaging-commands and control, File uploads with IoT Hub, Device firmware updates.
Azure IoT Communication Protocols:
Introduction, HTTPs, AMQP, Using AMQP library to communicate with IoT Hub, MQTT, IoT Protocol gateway, Using MQTT .NET library to communicate with IoT Hub, Connecting IoT Hub using MQTT client tools, How to choose between protocols.
(RBT Levels: L1 & L2).

Module-3

Azure IoT Hub Security and Best Practices:
Introduction, Securing a device with IoT Hub, securing a communication, IP filtering with IoT Hub,IoT Hub access rights, Security based practices.
IoT Suite and Pre-Configured Solutions:
Introduction, Creating a Pre-Configured solution, IoT Suite remote monitoring, IoT Suite predictive maintenance, IoT Suite connected factory, Customize an IoT Suite.
(RBT Levels: L1 & L2).

Module-4

Azure IoT Analytics:
Introduction, Connecting IoT Hub with Stream Analytics, Real-time dashboard reports for IoT data using Power BI, Azure Time Series Insights, IoT Edge analytics using a simulator, Real-time alerts with Azure functions.
(RBT Levels: L1 & L2).

Module-5

Using Real Devices to Connect and Implement Azure IoT Hub;
Install windows IoT Core on Raspberry PI, Connect and configure IoT core on Raspberry PI, Demo-Smart parking, temperature and humidity, Using an online Raspberry PI simulator.
Managing the Azure IoT Hub: Introduction, Device explorer for the Azure IoT Hub, using the IoT Hub Command-line tool, IoT Hub operation monitoring, The diagnostic metrics of the Azure IoT Hub, Scaling your IoT Hub solution.
(RBT Levels: L1 & L2).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Yatish Patil, "Azure IoT Development Cookbook Develop and manage robust IoT solutions, Packt publication
2. Kamil Mrzyglod,"Hands-On Azure for Developers: Implement rich Azure PaaS ecosystems using containers, serverless services, and storage solutions, Packt publication.

Web links and Video Lectures (e-Resources):

https://www.digimat.in › nptel › courses › video

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description
CO1	Understand the usage of Azure IoT Platform and different Device Management operations
CO2	Understand the different IoT Hub messaging commands and IoT Communication Protocols
CO3	Understand the Azure IoT Hub Security, best practices, IoT Suite and Pre-Configured Solutions
CO4	Understand the Azure IoT Analytics
CO5	Able to connect and Implement Azure IoT and to managing the Azure IoT Hub

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Ability Enhancement Courses

Machine Learning			
Course Code	MISS258A	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	1	Exam Hours	1 (MCQ)

Course Learning objectives: This Course will enable students to

- Define machine learning and understand the basic theory underlying machine learning.
- Differentiate supervised, unsupervised and reinforcement
- Understand Bayesian techniques for problems appear in machine learning
- Perform statistical analysis of machine learning techniques
- Understand the basic concepts of statistical learning and decision trees

Module-1

Introduction-Towards Intelligent Machines, Well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques.
(Text Book: 1) (RBT Levels: L1 & L2).

Module-2

Supervised Learning- Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Over fitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metrics for assessing classification.
(Text Book: 1) (RBT Levels: **L1 , L2& L3)**.

Module-3

Statistical Learning- Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.
(Text Book: 1) (RBT Levels: **L1, L2 & L3)**.

Module-4

Support Vector Machines (SVM) - Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly separable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, Regression by Support vector Machines.
(Text Book: 1) (RBT Levels: **L1, L2& L3)**.

Module-5

Learning with Neural Networks: Towards Cognitive Machine, Neuron Models, Network Architectures, Perceptrons, Linear neuron and the Widrow-Hoff Learning Rule, The error correction delta rule.
(Text Book: 1) (RBT Levels: **L1, L2& L3)**.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
3. Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
4. For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books:

1. Gopal, M., "Applied machine learning", McGraw-Hill Education, 2019.
2. Tom M Mitchell, "Machine Learning", McGraw-Hill science. Engineering/Math; 1997, ISBN: 0070428077.

Reference Books:

1. Müller, A. C., & Guido, S., "Introduction to machine learning with Python: a guide for data scientists", "O'Reilly Media, Inc." 2016.
2. Flach, P., "Machine learning: the art and science of algorithms that make sense of data" , Cambridge University Press, 2012.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106106139

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the concept of Machine Learning and Concept Learning	L2
CO2	Apply the concept of ML and various classification methods.	L3
CO3	Apply Bayes techniques and explore more about the classification in ML.	L3
CO4	Analyse various training models in ML and the SVM algorithm to be implemented	L3
CO5	Apply the ML concept in a decision tree structure and implementation of Ensemble learning and Random Forest.	L3

Automotive Sensor and In-Vehicle Networking			
Course Code	MISS258B	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	1	Exam Hours	1(MCQ)

Course Learning objectives: This Course will enable students to

- Learn basics of Electronics Systems in Automotive engineering.
- Understand the different sensors in Automotive Applications.
- Understand the different Automotive Networking protocols.
- Apply different control systems in automotive vehicles.
- Understand the various alternate Engines and advances in Automotive Electronic Systems.

Module-1

Introduction to Automotive engineering: Evolution of automotive electronics, Automobile physical configuration, Survey of major automotive systems.
Electrical and electronic systems in the vehicle: Overview, Electronic diesels control (EDC), Adaptive cruise control (ACC), and Occupant protection system.
Architecture of electronic systems: Overview, Vehicle system architecture
(Text Book: 1) (RBT Levels: L1 & L2).

Module-2

Automotive Sensors: Basics and overview, automotive applications, sensor classification.
Sensor types: Engine speed sensors, wheel speed sensors, Temperature sensors, Accelerator-pedal sensors, Steering-angle sensors, Axel sensors, Piezoelectric knock sensors, Piezoelectric acceleration sensors, Torque sensors, Rain/light sensors, Two step lambda oxygen sensors, LSU4 planer wide band lambda oxygen sensor.
(Text Book: 1) (RBT Levels: L1 & L2).

Module-3

Automotive Networking: Bus systems- Classification, Applications in the vehicle, coupling of networks, Examples of networked vehicles.
Buses- CAN Bus, UN Bus, MOST Bus, Bluetooth, FLEXRAY, Diagnostic Interfaces.
(Text Book: 1) (RBT Levels: L1 & L2).

Module-4

Vehicle Motion Control : Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS)
(Text Book: 1) (RBT Levels: L1 & L2).

Module-5

Automotive Diagnostics: Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems -Accelerometer based Air Bag systems.
Future Automotive Electronic Systems: Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation - Navigation Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving Control.
(Text Book: 1) (RBT Levels: L1 & L2).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
3. Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
4. For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books:

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing.
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106106139

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand basics of Electronics Systems in Automotive engineering.	L2
CO2	Use of the different sensors in Automotive Applications.	L2
CO3	Understand the different Automotive Networking protocols.	L2
CO4	Understand different control systems in Automotive vehicles.	L2
CO5	Describe the various alternate Engines and advances in Automotive Electronic Systems	L2

Biomedical Sensors			
Course Code	MISS258C	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	1	Exam Hours	1(MCQ)

Course Learning objectives: This Course will enable students to

- Different types of electrodes used in bio potential recording.
- Perceive the need for bio amplifiers and their characteristics needed to be design for various bandwidth and frequency response.
- Introduce the concept of Heart rate, Blood pressure and Blood Flow measurements.
- Students will be introduced to fundamentals of x-ray radiography and computed tomography
- Students will be introduced to principles of ultrasound imaging and thermal imaging..

Module-1

Biopotential Electrodes:
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.
EEG, EMG & ECG: Bio signal characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EEG- procedure, signal artefacts, signal analysis, evoked potential, EMG- procedure and signal analysis, Nerve conduction study.
(Text Book: 1) (RBT Levels: L1 & L2).

Module-2

Bio Amplifiers: Need for bio-amplifier-single ended bio-amplifier, differential bio-amplifier–right leg driven ECG amplifier. Bandpass filtering, isolation amplifiers–transformer and optical isolation- isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.
(Text Book: 1) (RBT Levels: L1 & L2).

Module-3

Measurement of Heart Rate: Average heart rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Oximeter.
Blood Flow Measurement: Electromagnetic blood flow meter- Principle and Square wave electromagnetic flow meter. Doppler shift blood flow velocity meter.
Blood Pressure Measurement: Introduction, Indirect methods of blood pressure measurement: Korotkoff's method, Rhopographic method, differential auscultatory technique, Oscillometer technique.
(Text Book: 1) (RBT Levels: L1 & L2).

Module-4

Ultrasound Imaging: Definition of ultrasound, Fundamentals of acoustic propagation (only theoretical concepts, no derivations) - Reflection and refraction, Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution.
(Text Book: 2) (RBT Levels: L1 & L2).

Module-5

Thermal Imaging: Medical thermography, Physics of thermography, Infrared detectors, Thermographic equipment, Quantitative medical thermography, Pyroelectric vidicon camera.
(Text Book: 2) (RBT Levels: L1 & L2).

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Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
3. Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
4. For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation" , Tata McGraw-Hill, New Delhi,3rd edition , 2014
2. Kirk Shung, Michael B. Smith and BanjaminTsui , "Principles of Medical Imaging" , Academic Press, 1992.

Reference books:

1. John Enderle, Joseph Bronzino, "Introduction to Biomedical Engineering", Academic Press, 3rd Edition, 2011.
2. Myer Kutz, "Biomedical Engineering and Design Handbook, Volume 1: Volume I:
3. Biomedical Engineering Fundamentals", McGraw Hill Publisher, USA, 2nd Edition 2009.
4. J. G. Webster, J. G. Webster ,"Medical Instrumentation; Application and Design", John Wiley & Sons, Inc., New York, 4th Edition, 2015

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/108/108108147/

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Realize the need for reusable electrodes and understand electrode placements for various bio potential recordings.	L2
CO2	Understanding the design concepts of bio-amplifiers and filters.	L2
CO3	Analyze Heart Rate, Blood Pressure and Blood Flow measurements.	L2
CO4	Understand the concepts of x-ray radiography and computed tomography.	L2
CO5	Understanding the concepts of ultrasound imaging and thermal imaging.	L2

Nano sensors			
Course Code	**MISS258D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	14	Total Marks	100
Credits	1	Exam Hours	1(MCQ)

Course Learning objectives: This Course will enable students to

- Understand sensor characteristics and physical effects.
- Understand the principle of nano based organic and inorganic sensors.
- Understand the different types of nano sensors for real time applications

Module-1

Sensor Characteristics: Active and Passive sensors – Static characteristic - Accuracy, offset and linearity, Dynamic characteristics - First and second order sensors. Physical effects involved in signal transduction - Photoelectric effect, Photo dielectric effect, Photoluminescence effect, Electroluminescence effect, Hall effect, Thermoelectric effect, Piezoresistive effect, Piezoelectric effect, Pyroelectric effect.

(Text Book: 1) (RBT Levels: L1 & L2).

Module-2

Sensor Characteristics and Physical Effects : Active and Passive sensors – Static characteristic - Accuracy, offset and linearity – Dynamic characteristics - First and second order sensors – Physical effects involved in signal transduction- Photoelectric effect – Photo dielectric effect – Photoluminescence effect – Electroluminescence effect – Hal effect – Thermoelectric effect – Piezoresistive effect – Piezoelectric effect – Pyroelectric effect –Magneto mechanical effect (magnetostriction) – Magneto resistive effect.

(Text Book: 1) (RBT Levels: L1& L2).

Module-3

Nano Based Inorganic Sensors: Density of states (DOS) – DOS of 3D, 2D, 1D and 0D materials – one dimensional gas sensors: - gas sensing with nano structured thin films – absorption on surfaces – metal oxide modifications by additives – surface modifications – nano optical sensors – nano mechanical sensors – plasmon resonance sensors with nano particles – AMR, Giant and colossal magneto resistors – magnetic tunnelling junctions.

(Text Book: 1) (RBT Levels: L1 & L2).

Module-4

Organic / Biosensors: Structure of Protein – role of protein in nanotechnology – using protein in nano devices – antibodies in sensing – antibody in nano particle conjugates – enzymes in sensing – enzyme nano particle hybrid sensors – Motor proteins in sensing – transmembrane sensors – Nano sensors based on Nucleotides and DNA – Structure of DNA – DNA decoders and microarrays – DNA protein conjugate based sensors – Bioelectronic sensors – DNA sequencing with nano pores – sensors based on molecules with dendritic architectures – biomagnetic sensors.

(Text Book: 1) (RBT Levels: L1 & L2).

Module-5

Nano Sensors: Temperature Sensors, Smoke Sensors, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry Biosensors.

(Text Book: 1) (RBT Levels: L1 & L2).

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

1. For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
2. The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
3. Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
4. For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books:

1. Kourosh Kalantar – Zadeh, Benjamin Fry, "Nanotechnology- Enabled Sensors", Springer, 2. H. Rosemary Taylor, "Data acquisition for sensor systems", Chapman & Hall, 1997.

Reference books:

1. Jerome Schultz, Milan Mrksich, Sangeeta N. Bhatia, David J. Brady, Antonio J. Ricco, David R. Walt, Charles L. Wilkins, "Biosensing: International Research and Development", Springer.
2. Ramon Pallas-Areny, John G. Webster, "Sensors and signal conditioning" John Wiley &Sons, 2001.
3. Vijay.K.Varadan, Linfeng Chen, Sivathanupillai, "Nanotechnology Engineering in Nano and Biomedicine", John Wiley & Sons, 2010.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/108/108108147/

Skill Development Activities Suggested

- The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Explain sensor characteristics and its physical effects.	L2
CO2	Explain the principle of nano based organic and inorganic sensors.	L2
CO3	Explain the different types of nano sensors for real time applications	L2

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