VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

## SCHOOL OF ELECTRONICS ENGINEERING

# M. Tech Internet of Things & Sensor Systems

(M.Tech MTS)

Curriculum

(*2024-25 admitted students*)

## VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

## MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

**World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

**Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.

**Impactful People**: Happy, accountable, caring and effective workforce and students.

**Rewarding Co-creations**: Active collaboration with national & international, industries & universities for productivity and economic development.

**Service to Society**: Service to the region and world through knowledge and compassion.

## VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

## MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life.

## M. Tech Internet of Things & Sensor Systems

# PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry
3. Graduates will function in their profession with social awareness and responsibility
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country
5. Graduates will be successful in pursuing higher studies in engineering or management
6. Graduates will pursue career paths in teaching or research

# M. Tech Internet of Things & Sensor Systems

## PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_03: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_04: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_05: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_06: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management skills related to project management and finance

## M. Tech Internet of Things & Sensor Systems

# PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech. (Internet of Things & Sensor Systems) programme, graduates will be able to

- PSO1: Competent, and innovative with a strong cognizance in the area of sensors, IoT, data science, controllers and signal processing through the application of acquired knowledge and skills

- PSO2: Apply advanced techniques and tools of sensing and computation to solve multi-disciplinary challenges in industry and society.

- PSO3: To exhibit independent and collaborative research with strategic planning, while demonstrating the professional and ethical responsibilities of the engineering profession.

| Category Credit Detail | | | |
|---|---|---|---|
| **Sl.No.** | **Description** | **Credits** | **Maximum Credit** |
| 1 | DC - Discipline Core | 24 | 24 |
| 2 | DE - Discipline Elective | 12 | 12 |
| 3 | PI - Projects and Internship | 26 | 26 |
| 4 | OE - Open Elective | 3 | 3 |
| 5 | SE - Skill Enhancement | 5 | 5 |
| **Total Credits** | | 70 | |

| Discipline Core | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **sl.no** | **Course Code** | **Course Title** | **Course Type** | **Version** | **L** | **T** | **P** | **J** | **Credits** |
| 1 | MITS507L | Signal Processing and Data Analytics | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MITS509L | Sensor Technology and Data Acquisition | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 3 | MITS509P | Sensor Technology and Data Acquisition Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 4 | MITS510L | IoT Architecture | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 5 | MITS510P | IoT Architecture Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 6 | MITS511L | Microsystems Fabrication Technology | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 7 | MITS512L | Microcontrollers and Interfacing | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 8 | MITS512P | Microcontrollers and Interfacing Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 9 | MITS513L | Wireless Sensor Networks and Data Communication | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 10 | MITS514L | Robotics and Control Systems | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 11 | MITS514P | Robotics and Control Systems Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |

| Discipline Elective | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **sl.no** | **Course Code** | **Course Title** | **Course Type** | **Version** | **L** | **T** | **P** | **J** | **Credits** |
| 1 | MEDS501L | Embedded System Design | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MEDS601L | Electromagnetic Interference and Compatibility | Theory Only | 2.0 | 3 | 0 | 0 | 0 | 3.0 |
| 3 | MEIC506L | Wireless Communications | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 4 | MITS601L | Flexible and Wearable Sensors | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 5 | MITS603L | Chemical and Environmental Sensor | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 6 | MITS604L | Cloud and Fog Computing | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 7 | MITS605L | IoT Security and Trust | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 8 | MITS608L | RF and Microwave Sensors | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 9 | MITS611L | Automotive Sensors and In-Vehicle Networking | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 10 | MITS612L | Fibre Optic Sensors and Photonics | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 11 | MITS613L | System-on-chip | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 12 | MITS614L | Deep Learning | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 13 | MITS615L | Web Design and Development | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 14 | MITS616L | Edge and Distributive Computing | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |

| Projects and Internship | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| sl.no | Course Code | Course Title | Course Type | Version | L | T | P | J | Credits |
| 1 | MITS698J | Internship I/ Dissertation I | Project | 1.0 | 0 | 0 | 0 | 0 | 10.0 |
| 2 | MITS699J | Internship II / Dissertation II | Project | 1.0 | 0 | 0 | 0 | 0 | 12.0 |
| 3 | MSET695J | Project Work | Project | 1.0 | 0 | 0 | 0 | 0 | 4.0 |

| Open Elective | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| sl.no | Course Code | Course Title | Course Type | Version | L | T | P | J | Credits |
| 1 | MFRE501L | Francais Fonctionnel | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MGER501L | Deutsch fuer Anfaenger | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 3 | MSTS601L | Advanced Competitive Coding | Soft Skill | 1.0 | 3 | 0 | 0 | 0 | 3.0 |

| Skill Enhancement | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| sl.no | Course Code | Course Title | Course Type | Version | L | T | P | J | Credits |
| 1 | MENG501P | Technical Report Writing | Lab Only | 1.0 | 0 | 0 | 4 | 0 | 2.0 |
| 2 | MSTS501P | Qualitative Skills Practice | Soft Skill | 1.0 | 0 | 0 | 3 | 0 | 1.5 |
| 3 | MSTS502P | Quantitative Skills Practice | Soft Skill | 1.0 | 0 | 0 | 3 | 0 | 1.5 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS507L | Signal Processing and Data Analytics | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. To introduce the concepts of discrete time signal processing and the characterizationof random signals.
2. To present the basic theory of modeling the signals and the methods of estimating theunknowns using prediction filters
3. To provide a comprehensive understanding on applying FFT, DCT, and wavelettechniques for extracting the signal features.
4. To provide an overview of analysing big data using intelligent techniques and an in-depth introduction to two main areas of Machine Learning: supervised and unsupervised.

**Course Outcomes:**

1. Apply FFT, DCT wavelet techniques for extracting the features from the big data
2. Develop algorithms that can be used to analyse the real-world univariate and multivariatetime series data.
3. Design an approach to leverage data using the steps in the machine learning process.
4. Understand and apply both supervised and unsupervised classification methods to detectand characterize patterns in real-world data.
5. Estimate the signal parameters and identify the model using ARMA models andprediction filters.
6. Understand the methods of visualization and analysis of big data.

| Module:1 | Discrete Random Signal Processing | 7 hours |
|---|---|---|

Random Processes, Ensemble Average, Gaussian Process, Multi variate Gausssian Process, Stationary process, Autocorrelation, Auto Covariance, Ergodicity, White noise, Power Spectrum,Filtering of Random Process

| Module:2 | Signal Modeling | 6 hours |
|---|---|---|

ARMA, AR, MA Models. Wiener filter, Linear prediction, Kalman Filter.

| Module:3 | Feature extraction | 6 hours |
|---|---|---|

FFT, Power spectrum, DCT, filter banks, Wavelet, Wavelet Packets, Cepstrum

| Module:4 | Time series analysis | 6 hours |
|---|---|---|

Basic analysis, Univariate time series analysis, Multivariate time series analysis, non stationary time series.

| Module:5 | Reduction of dimensionality | 6 hours |
|---|---|---|

Bayesian decision, Linear discrimination, Principal Component analysis, SVD, Independent Component Analysis.

| Module:6 | Machine learning | 6 hours |
|---|---|---|

Supervised learning, generative algorithms, Support Vector machines, Unsupervised learning, K means clustering, Neural network (SOM, ART), Expectation maximization.

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|---|---|---|
| **Module:7** | **Big Data Analytics** | **6 hours** |
| Introduction Big data analytics, visualization and data exploration, basic and intermediate analysis, linear and logistic regression, decision tree. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture:** | **45 hours** |

**Text Book(s)**

1. J. G. Proakis, DG. Manolakis and D. Sharma, “Digital signal processing principles,algorithms and applications”, 2012, 4th ed., Person education, USA.
2. Sophocles J. Orfanidis, “Inroduction to signal Processing” 2010, 2nd ed., Prentice Hall, NewDelhi India.

**Reference Books**

1. Oppenhiem V. A.V and Schaffer R. W, “Discrete- time signal Processing”, 2014, 3rd ed.,Prentice Hall,. New Delhi, India
2. Thomas A. Runkler, "Data Analytics: Models and Algorithms for Intelligent Data Analysis", 2016, 2nd ed., Springer Verlag, UK
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective" 2012, 1st ed., MITPress, USA

Mode of Evaluation: CAT / Assignment / Quiz / FAT

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|---|---|---|---|
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS509L | Sensor Technology and Data Acquisition | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To provide in depth knowledge in physical principles applied in sensing, measurement anda comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
2. To introduce the students to sources and detectors of various Optical sensing mechanismsand provide in-depth understanding of the principle of measurement, and theory of instruments and sensors for measuring velocity and acceleration
3. To give a fundamental knowledge on the basic laws and phenomena on which operation ofsensor transformation of energy is based.
4. To impart a reasonable level of competence in the design, construction, and execution ofmechanical measurements strain, force, torque and pressure
5. To explore the fundamentals of data acquisition using sensors, NI data acquisition hardware, and LabVIEW.

**Course Outcomes**

1. Use concepts in common methods for converting a physical parameter into an electricalquantity
2. Choose an appropriate sensor comparing different standards and guidelines to makesensitive measurements of physical parameters like pressure, flow, acceleration, etc.
3. Design and develop sensors using optical methods with desired properties
4. Evaluate performance characteristics of different types of sensors
5. Locate different types of sensors used in real life applications and paraphrase theirimportance
6. Create analytical design and development solutions for sensors and Develop PC-based data acquisition and signal conditioning.
7. Compete in the design, construction, and execution of systems for measuring physicalquantities and develop virtual experiment models

| Module:1 | Sensor fundamentals, characteristics and data acquisition | 8 hours |
|---|---|---|

Sensor Classification, Performance and Types, Error Analysis characteristics. Introduction to data acquisition, Virtual instrumentation, Principles of Analog Signal conditioning: Differential and instrumentation amplifiers, I to V and V to I converters. Converters: Comparators, DACs, ADCs, Sample and hold.

| Module:2 | Optical Sources and Detectors | 4 hours |
|---|---|---|

Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photodiodes, Avalanche photodiodes, CCDs.

| Module:3 | Intensity Polarization and Interferometric Sensors | 4 hours |
|---|---|---|

Intensity sensor, Microbending concept, Interferometers, Mach Zehnder, Michelson, Fabry Perot and Sagnac, Phase sensor: Phase detection, Polarization maintaining fibers.

| Module:4 | Strain, Force, Torque and Pressure sensors and data | 8 hours |
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|---|---|---|
| | **acquisition techniques.** | |
| Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors. Design of signal conditioning circuits for strain gauges, piezo, capacitance and optoelectronics sensors, Design and development of data acquisition systems for strain, force, pressure and piezo sensors. | | |
| **Module:5** | **Position, Direction, Displacement and Level Sensors and data acquisition techniques.** | **8 hours** |
| Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magnetostrictive sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. Signalcondition circuits for reactive and self generating sensors. Design and development of data acquisition systems for position, direction, displacement and level sensors. | | |
| **Module:6** | **Velocity and Acceleration sensors** | **4 hours** |
| Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithicand optical gyroscopes. | | |
| **Module:7** | **Flow, Temperature and Acoustic sensors and data acquisition techniques** | **7 hours** |
| Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic andLaser anemometer. microflow sensor, coriolis mass flow and drag flow sensor. Temperature sensors- thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor. Acoustic sensors-microphones-resistive, capacitive, piezoelectric, fiber optic, solid state - electrect microphone. Design and development of data acquisition system for flow temperature and acoustic sensors. Development of sensor systems using Lab view case studies | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | **Total Hours** | **45 hours** |

| **Text Book(s)** | |
|---|---|
| 1 | Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York. |
| 2. | Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland. |
| **Reference Books** | |
| 1. | GerdKeiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. |
| 2. | John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition,CRC Press, Florida. |
| 3. | Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers andscientists", 2013, 2nd edition, Wiley, New Jersey. |
| 4. | Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition,John Wiley, New York. |

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| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT. | | | |
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS509P | Sensor Technology and Data Acquisition Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To provide in depth knowledge in physical principles applied in sensing, measurement anda comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
2. To introduce the students to sources and detectors of various Optical sensing mechanismsand provide in-depth understanding of the principle of measurement, and theory of instruments and sensors for measuring velocity and acceleration
3. To give a fundamental knowledge on the basic laws and phenomena on which operation ofsensor transformation of energy is based.
4. To impart a reasonable level of competence in the design, construction, and execution of mechanical measurements strain, force, torque and pressure

**Course Outcomes**

1. Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc.
2. Design and develop sensors using optical methods with desired properties
3. Evaluate performance characteristics of different types of sensors
4. Locate different types of sensors used in real life applications and paraphrase their importance
5. Perform different types of data acquisition and identify the correct sensor for their measurements. Develop integrated, high-performance data acquisition systems that produce accurate measurements
6. Acquire data from sensors, such as thermocouples and strain gages, using NI DAQ hardware and analyze the results in LabVIEW and MATLAB
7. Apply advanced understanding of LabVIEW and the NI-DAQmx API to create applications

**Indicative Experiments**

1. Design of signal conditioning circuits for strain gauges- Strain, Force, pressure,and torque measurement
   - I. Strain measurement with Bridge Circuit
   - II. Beam force sensor using Strain Gauge Bridge
   - III. Beam deflection sensing with Strain Gauge Bridge
   - IV. Diaphragm pressure sensor using Strain Gauge Bridge
   - V. Shear strain and angle of shift measurement of hollow shaft

   After completing the 1st set of characteristics. Design a weighing machine having arange of 0-5 Kg with a sensitivity of 5 mg. What modification he/she has to do tochange the upper range to 100 Kg with a sensitivity of 100 mg.
2. Develop a displacement measurement system with the following sensors:
   - i. Inductive transducer (LVDT)
   - ii. Hall effect sensor

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| 3. | After studying the characteristics of temperature sensors listed below, develop a temperature measurement system for a particular application using the suitablesensor.<br>i. Thermocouple principles<br>ii. Thermistor and linearization of NTC Thermistor<br>Iii. Resistance Temperature Detector<br>iv. Semiconductor Temperature sensor OA79<br>v. Current output absolute temperature sensor |
| 4. | Develop a sensor system for force measurement using piezoelectric transducer |
| 5. | Measurement of shear strain and angle twist using strain gauge is not suitable for many applications. Based on other sensing experiments carried out suggest a non-contact method and try to complete its proof of concept. |
| 6. | LabVIEW Graphical Programming, NI DAQmx, Data acquisition Toolbox to read data into MATLABand Simulink and write data into DAQ device |
| 7. | Acquire and generate analog signals.<br>Acquire and generate non-clocked digital data.<br>Measure frequency, pulse width and count pulses using NI devices<br>Generate Pulse Width Modulated signal |
| **Total Laboratory Hours** | **30 hours** |
| **Text Book(s)** | |
| 1 | Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rdedition, Springer, New York. |
| 2. | Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland. |
| **Reference Books** | |
| 1. | GerdKeiser,"Optical Fiber Communications", 2017, 5th edition, McGraw-Hill Science, Delhi. |
| 2. | John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition,CRC Press, Florida. |
| 3. | Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers andscientists", 2013, 2nd edition, Wiley, New Jersey. |
| 4. | Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition,John Wiley, New York. |

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| Mode of assessment: Continuous assessment / FAT / Oral examination and others | | | |
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS510L | IoT Architecture | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Introduce evolution of internet technology and need for IoT.
2. Discuss on IoT reference layer and various protocols and software.
3. Train the students to build IoT systems using sensors, single board computers and open sourceIoT platforms.
4. Make the students to apply IoT data for business solution in various domain in secured manner.

**Course Outcomes**

1. Identify the IoT networking components with respect to OSI layer.
2. Build schematic for IoT solutions.
3. Design and develop IoT based sensor systems.
4. Select IoT protocols and software.
5. Evaluate the wireless technologies for IoT.
6. Appreciate the need for IoT Trust and variants of IoT.

| Module:1 | Evolution of IoT | 7 hours |
|---|---|---|
| Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting, IPV4 addressing and challenges). IPV6 addressing. IoT architecturereference layer. | | |
| **Module:2** | **Introduction to IoT components** | **6 hours** |
| Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single boardcomputers, open source hardwares, Examples of IoT infrastructure | | |
| **Module:3** | **IoT protocols and softwares** | **6 hours** |
| MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP, COAP,XMPP and gateway protocols, | | |
| **Module:4** | **IoT point to point communication technologies** | **6 hours** |
| IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies ( 6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA, Lifi, Widi) | | |
| **Module:5** | **Introduction to Cloud computation and Bigdata analytics** | **6hours** |
| Evolution of Cloud Computation, Commercial clouds and their features, open source IoT platforms, cloud dashboards, Introduction to big data analytics and Hadoop. | | |
| **Module:6** | **IoT security** | **6hours** |
| Need for encryption, standard encryption protocol, light weight cryptography, Quadruple TrustModel for IoT-A – Threat Analysis and model for IoT-A, Cloud security | | |
| **Module:7** | **IoT application and its Variants.** | **6 hours** |
| **Case studies:** IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Hours** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions withthe IoT Architecture Reference Model", Springer |

| | |
|---|---|
| | Open, 2016 |
| 2. | Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014. |
| **Reference Books** | |
| 1. | LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008. |
| 2. | Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014. |
| 3. | Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill,2010. |
| 4 | Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010 |
| 5 | RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to SecureCloud Computing,Wiley-India, 2010 |
| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT. | |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS510P | IoT Architecture Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Introduce evolution of internet technology and need for IoT.
2. Discuss on IoT reference layer and various protocols and software.
3. Train the students to build IoT systems using sensors, single board computers and open source
4. IoT platforms.
5. Make the students to apply IoT data for business solution in various domain in secured manner.

**Course Outcomes**

1. Identify the IoT networking components with respect to OSI layer.
2. Build schematic for IoT solutions
3. Design and develop IoT based sensor systems.
4. Select IoT protocols and software.
5. Evaluate the wireless technologies for IoT.
6. Appreciate the need for IoT Trust and variants of IoT.

| **Indicative Experiments** | |
|---|---|
| 1. | C programming |
| 2. | C++/JAVA programming |
| 3. | Python programming |
| 4. | Thinkspeak/thingsboard cloud platforms |
| 5. | Nodered |
| 6. | IoT usecases |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions withthe IoT Architecture Reference Model", Springer Open, 2016 |
| 2. | Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014. |

**Reference Books**

| | |
|---|---|
| 1. | LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008. |
| 2. | Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014. |
| 3. | Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill,2010. |
| 4 | Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010 |
| 5 | RonaldL. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to SecureCloud Computing, Wiley-India, 2010 |

| | | | |
|---|---|---|---|
| Mode of assessment: Continuous assessment / FAT / Oral examination and others | | | |
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS511L | Microsystems Fabrication Technology | 3 | 0 | 0 | 3 |
| Prerequisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamental concepts of MEMS based sensors and actuators.
2. To acquaint the students with various materials and material properties for Microsystem designing.
3. To provide comprehensive understanding of various micromachining techniques and expose the students to design, simulation and analysis software.
4. Enhancing the basics of thick film and hybrid technologies for sensor development.

**Course Outcomes**

1. Identify and understand the fundamental concepts and background of MEMS and Microsystems
2. Familiar with the basics of various sensors and actuators.
3. The students were acquainted with various materials for Microsystem designing.
4. Determine and compare the scaling effects in miniaturizing devices.
5. Recognize and interpret various micromachining techniques and design, analysis and applications of various MEMS devices micromachining tools and techniques
6. Acquainted with thick film and hybrid technologies for sensor development.
7. Incorporate simulation and micro-fabrication knowledge for developing various MEMS devices.

| Module:1 | Introduction to MEMS and Microsystems | 7 hours |
|---|---|---|

MEMS and Microsystems, Miniaturization, Benefits of Microsystems, Typical MEMS andMicrosystems products, Evolution of Micro fabrication and Applications.

| Module:2 | Introduction to Sensors and Actuators | 6 hours |
|---|---|---|

Various domains and classification of transducers: electrostatic, piezoelectric, thermal. Sensing principles: electrostatic, resistive, chemical etc. SAW devices. Micro actuators, Design of Micro accelerometers, Engineering Science for Microsystem design and fabrication.

| Module:3 | Materials for Microsystems | 6 hours |
|---|---|---|

Silicon, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric materials, Polymers, Shape Memory Alloys, ferroelectric and rheological materials.

| Module:4 | Scaling Effects in Microsystems | 6 hours |
|---|---|---|

Introduction to Scaling, Scaling laws, Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electromagnetic, Electrostatic, magnetic, optical and Thermal domains. Scaling in Fluid mechanics.

| Module:5 | Micromachining Technologies | 6 hours |
|---|---|---|

Overview of silicon processes techniques, Photolithography, Ion Implantation, Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.

| Module:6 | MEMS and micro systems applications | 6 hours |
|---|---|---|

Details of application in actual systems, introduction to RF- MEMS, MOEMS, future of smart structures and MEMS leading to NEMS. Packaging, test and calibration of MEMS.

| **Module:7** | **Hybrid Technology** | **6 hours** |
|---|---|---|
| Thick-film and hybrid technology in sensor production. Basic materials, components, manufacturing Screen manufacturing, Screen printing, Parameters, Comparison: thick- vs. thin-film technology Structure dimensions, Assembly and packaging Surface mount technology (SMT)Active and passive devices (SMD), Connection technologies, Packaging. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| **Total Hours** | | **45 hours** |
| **Text Book(s)** | | |
| 1. | G.K.Ananthasuresh, K J Vinoy, S Gopalakrishnan, KN Bhatt, V K Aatre," Micro and smartsystems", 2012, 1st ed., Wiley, New York. | |
| 2. | Tai-Ran Hsu, "MEMS & Microsystem, Design and Manufacture", 2017, 1st ed., McGraw HillIndia, New Delhi. | |
| **Reference Books** | | |
| 1. | Mahalick NP, "MEMS", 2017, 1st ed., Tata McGraw Hill, New Delhi | |
| 2 | Wolfgang Menz, Jürgen Mohr, Oliver Paul, "Microsystem Technology", 2011, 2nd ed., Wiley,New York. | |
| 3 | Banks H.T. Smith R.C. and Wang Y.Smart, 'Material Structures – Modeling, Estimation andControl', 2011, 1st ed., John Wiley & Sons, NewYork. | |
| 4 | Massood Tabib – Arar, 'Microactuators – Electrical, Magnetic Thermal, Optical, Mechanical,Chemical and Smart structures', 2014, 1st ed., Kluwer Academic publishers, New York. | |
| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT. | | |

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|---|---|---|---|
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS512L | Microcontrollers and Interfacing | 3 | 0 | 0 | 3 |
| Prerequisite | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Introduce low power microcontrollers and to develop the skill set of programming low power sensing applications.
2. Impart the knowledge of various peripheral related to sensing and communication using wired or wireless means.
3. Upgrade the students by introducing them Advanced ARM Cortex microcontrollers
4. Develop the skill set of students to build IoT systems and sensor interfacing.

**Course Outcomes**

1. Design and develop embedded programs for low power microcontrollers for sensor applications.
2. Develop ARM basic and advanced programs.
3. Interface and deploy analog and digital sensors
4. Develop communication system with sensor units
5. Design develop IoT systems using Wi-Fi CC3200.
6. Program the single board computers to read sensor data and posting in cloud.

| Module:1 | MSP430 microcontrollers | 7 hours |
|---|---|---|
| Architecture of the MSP430, Memory, Addressing modes, Reflections on the CPU instruction set. Clock system, Exceptions: Interrupts and resets. Functions and subroutines, Mixing C and assembly language, Interrupts, Interrupt service routines, Issues associated with interrupts, Low-power modes of operation. | | |
| **Module:2** | **ARM Cortex MX microcontroller** | **6 hours** |
| ARM Cortex M4: Assembly language basics, Thumb-2 Technology, ARM Instruction set, Cortex M4 architecture, advantages, peripherals, instruction set, floating point operations, AdvancedCortex MX Microcontroller, core, architecture, on-chip wi-fi. | | |
| **Module:3** | **Display and Communication modules** | **6 hours** |
| GPIO, LCD display, graphical display, relays, Peripheral programming SPI, I2C, UART, Zigbeecontroller. | | |
| **Module:4** | **Sensors interfacing** | **6 hours** |
| Sensors interfacing techniques- Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11, single wire thermometer, Frequency counters. | | |
| **Module:5** | **Microcontrollers for IoT** | **6 hours** |
| ESP8266, NodeMCU, TI-CC3200, Access point and station point mode, HTTP, MQTT, transmission and receiving, Intel-Gallileo boards. | | |
| **Module:6** | **Single board computers** | **6 hours** |
| Raspberry pi board, porting Raspbian, sensor interface examples, Python programming for cloudaccess, sensor systems using Arduino boards | | |
| **Module:7** | **Cloud interfacing** | **6 hours** |
| Interfacing and data logging with cloud: Thing speak, Things board, Blync platform. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| **Total Hours** | | **45 hours** |

**Text Book(s)**

1. John H. Davies, "MSP430 Microcontroller Basics", 2011, 2nd ed., Newnes

| | |
|---|---|
| | publishing, NewYork. |
| 2. | Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2014, 4th ed., Springer, New York. |
| **Reference Books** | |
| 1. | Sergey Y. Yurish,"Digital Sensors and Sensor Systems: Practical Design", 2011, 1st ed., IFSApublishing, New York. |
| 2. | Jonathan W Valvano, "Introduction to ARM Cortex –M3 Microcontrollers", 2012, 5th ed.,Create Space publishing, New York. |
| 3. | Muhammad Ali Mazidi, Shujen Chen, SarmadNaimi, SepehrNaimi, "TI ARM PeripheralsProgramming and Interfacing: Using C Language", 2015, 2nd ed., Mazidi and Naimi publishing, New York. |
| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT. | |

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|---|---|---|---|
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS512P | Microcontrollers and Interfacing Lab | 0 | 0 | 2 | 1 |
| Prerequisite: | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Introduce low power microcontrollers and to develop the skill set of programming lowpower sensing applications.
2. Impart the knowledge of various peripheral related to sensing and communication usingwired or wireless means.
3. Upgrade the students by introducing them Advanced ARM Cortex microcontrollers
4. Develop the skill set of students to build IoT systems and sensor interfacing.

**Course Outcomes**

1. Design and develop embedded programs for low power microcontrollers for sensor applications.
2. Develop ARM basic and advanced programs.
3. Interface and deploy analog and digital sensors
4. Develop communication system with sensor units
5. Design develop IoT systems using Wi-Fi CC3200.
6. Program the single board computers to read sensor data and posting in cloud.

**Indicative Experiments**

| | |
|---|---|
| 1. | Working with MSP430 (CCStudio)<br>Sub Task 1: Port programming of MSP430 microcontrollers<br>Sub Task 2: Analog to Digital Conversion using MSP430 microcontroller<br>Sub Task 3: LCD display of characters and numbers.<br>Sub Task 4: Timer |
| 2. | Working with ARM (Keil and energia)<br>Sub Task 1: Peripheral programming of ARM7 board<br>Sub Task 2: PWM generation<br>Sub Task 3:Configuring CC3200, wifi configuration ,HTTP and MQTTProtocol |
| 3. | Low power wireless transmission using Zigbee<br>Sub Task 1: Interfacing Zigbee controller with MSP 430 microcontrollerusing SPI/UART.<br>Sub Task 2: Programming sleep and wake up mode of MSP 430. |
| 4. | IoT systems<br>Working with Raspberry pi using Python.<br>Arduino platform<br>Working with open source clouds |

| | |
|---|---|
| **Total Laboratory Hours** | **30 hours** |

| **Text Book(s)** | | | | |
|---|---|---|---|---|
| 1. | John H. Davies, "MSP430 Microcontroller Basics", 2011, 2nd ed., Newnes publishing, NewYork. | | | |
| **Reference Books** | | | | |
| 1. | Sergey Y. Yurish,"Digital Sensors and Sensor Systems: Practical Design", 2011, 1st ed., IFSApublishing, New York. | | | |
| Mode of assessment: Continuous assessment / FAT / Oral examination and others | | | | |
| Recommended by Board of Studies | | 07-06-2023 | | |
| Approved by Academic Council | | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS513L | Wireless Sensor Networks and Data Communication | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To identify and expose the students to the central elements in the design of communication protocols for the WSNs.
2. To disseminate the design knowledge in analyzing the specific requirements for applications in WSNs regarding energy supply, memory, processing, and transmission capacity
3. To get the perception of mobile ad hoc networks, design, implementation issues, and solutions based on different algorithms and protocols for power management, sensor data routing and query processing.
4. To associate, hardware platforms and software frameworks used to realize dynamic Wireless sensor network

**Course Outcomes**

1. Assess the applicability and limitations of communication protocols for a real time WSNapplication.
2. Confirms the behavior of mobile ad hoc networks (MANETs) and correlates the infrastructure-based networks.
3. Proactive in understating the routing protocols function and their implications on datatransmission delay and bandwidth.
4. Able to establish networks with an attempt to reduce issue of broadcast and flooding techniques.
5. Contribute appropriate algorithms to improve existing or to develop new wireless sensornetwork applications.
6. Familiarize the protocol, design requirements, suitable algorithms, and the state-of-the-art cloudplatform to meet the industrial requirement.
7. On a profound level to implement hardware & software for wireless sensor networks in day today life

| Module:1 | Network for embedded systems | 6 hours |
|---|---|---|

RS232, RS485, SPI, I2C, CAN, LIN, FLEXRAY.

| Module:2 | Embedded wireless communication and Protocols | 6 hours |
|---|---|---|

Bluetooth, Zigbee, Wifi, MiWi, Nrf24, Wireless LAN &PAN, UWB

| Module:3 | Wireless sensor network (WSN) | 6 hours |
|---|---|---|

Characteristic and challenges, WSN vs Adhoc Networks, Sensor node architecture, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme,Dynamic modulation scaling, Antenna considerations.

| Module:4 | WSN (Medium access control) | 6 hours |
|---|---|---|

Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts, Contention Basedprotocols, Schedule-based protocols - SMAC – BMAC, Traffic-adaptive medium access protocol (TRAMA), The IEEE 802.15.4 MAC protocol.

| Module:5 | Sensor Network Architecture | 7 hours |
|---|---|---|

Data Dissemination, Flooding and Gossiping-Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs-Gateway Concepts, Need for gateway, WSNand Internet Communication, WSN

| | | |
|---|---|---|
| Tunneling | | |
| **Module:6** | **IP based WSN** | **6 hours** |
| Circuit switching, packet switching, concept of IPV4, IPV6, 6LOWPAN and IP, IP based WSN,6LOWPAN based WSN. | | |
| **Module:7** | **Tiny OS** | **6 hours** |
| Tiny OS for WSN and IoT, M2M communication, Alljoyn network | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| **Total Hours** | | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks"2011, 1st ed., John Wiley & Sons, New Jersey. |
| 2 | Jun Zheng, Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective",2014, 1st ed., Wiley-IEEE Press, USA. |
| **Reference Books** | |
| 1. | Waltenegus W. Dargie, Christian Poellabauer, "Fundamentals of Wireless SensorNetworks: Theory and Practice", 2014, 1st ed., John Wiley & Sons, New Jersey. |
| 2 | Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", 2011, 1st ed., JohnWiley & Sons, New Jersey. |
| 3 | Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", 2009, 1sted., John Wiley & Sons, New Jersey. |

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|---|---|---|---|
| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT. | | | |
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS514L | Robotics and Control Systems | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To impart knowledge on performance specification, limitations and structure of controllers
2. To impart knowledge on design of controllers using root-locus and frequency domain techniques
3. To get an exposure on Robotic control systems and open source soft ware

**Course Outcomes**

1. Able to model the system and simulate the model.
2. Perform system analysis in time domain and frequency domain.
3. Analyze the system stability based on time domain, frequency domain and root locus techniques.
4. Develop digital control algorithms. Have a basic understanding of Robotics.
5. Have an understanding of the basic building blocks of robotic systems
6. Understand Dynamics of Robot control and path planning
7. Understand robot simulation and programming using ROS

| Module:1 | Time Domain Analysis and Design | 3 hours |
|---|---|---|

First order, Second order control system response for step, ramp and impulse inputs. characteristic equation -Poles and Zeroes concept- stability and Routh criterion

| Module:2 | Root Locus Techniques | 3 hours |
|---|---|---|

Review of root locus construction – Lead/ Lag compensator design using root locus.

| Module:3 | Frequency Response Techniques | 3 hours |
|---|---|---|

Bode plots and stability- gain and phase margins- Lead/ Lag compensator design using Bode plots.

| Module:4 | Analog and Digital Controllers | 5 hours |
|---|---|---|

P, PI, PD, PID Controller- Basic control action - Effects of Derivative, Integral control actions-Design of P, PI, PID controllers – Tunable PID Controllers – Ziegler –Nichols Methods for Controller Tuning, Fuzzy logic controllers.

| Module:5 | Robotics-Sensors and Actuators for Robotics | 6 hours |
|---|---|---|

Types of Robots-Robot components, classifications, and specifications. Mathematical Modeling of Robots, Robots as Mechanical Devices, Common Kinematic Arrangements, Robotic actuators: Electric-DC, Servo & Stepper, hydraulic and pneumatic actuators, Drives for motors. Sensors for localization, navigation, obstacle avoidance and path planning in known and unknown environments: Tactile sensors, Proximity and range sensors, Acoustic sensors, Vision sensor systems

| Module:6 | Kinematics, Dynamics and Path Planning | 4 hours |
|---|---|---|

Kinematics of manipulators: Representing Positions, Representing Rotations, Rotational Transformations, Composition of Rotations, Parameterizations of Rotations, Rigid Motions, Homogeneous transformations, Denavat – Hartenberg

| | | |
|---|---|---|
| representation, Inverse kinematics. The Configuration Space, Path Planning, Trajectory planning, SLAM | | |
| **Module:7** | **Robot Operating System** | **4 hours** |
| Introduction to ROS and Gazebo, setting up workspaces, launching basic robotic simulations – SLAM using turtlebots | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | | |
| **Total Hours** | | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | Katsuhiko Ogata, "Modern Control Engineering", 2015, 5th ed., Prentice Hall, New JerseyUSA. |
| 2 | Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", 2nd Edition, Wiley Publisher, 2020. |
| **Reference Books** | |
| 1. | I. J. Nagrath and M. Gopal, "Control Systems Engineering", 2017, 6th Ed., New Age International (p) Limited. New Delhi, India. |
| 2 | Norman S Nise, "'Control systems engineering",2018, Wiley India edition, Wiley |
| 3 | Richard Dorf, Robert Bishop,"Modern Control Systems", 2016, 13th Edition, Pearson, India. |
| 4 | R K Mittal. I.J.Nagrath, 'Robotics and control",2017,Mcgraw Hill education |

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT. | | | |
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS514P | Robotics and Control Systems Lab | 0 | 0 | 2 | 1 |
| Prerequisite: | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To impart knowledge on performance specification, limitations and structure of controllers
2. To impart knowledge on design of controllers using root-locus and frequency domain techniques

**Course Outcomes**

1. Realize the need of control system and its recent developments. Able to model the system and simulate the model.
2. Analyze the behavior of the first and second order systems in time domain and frequency domain.
3. Analyze the system stability based on time domain, frequency domain and root locus techniques.
4. Identify the need for incorporating the three term controller based on the customized requirement of the control action
5. Analyze the systems behavior in digital domain and develop digital control algorithm for the corrective action.
6. Design and development of Bot control and mapping algorithms using ROS.

| **Indicative Experiments** | |
|---|---|
| 1. | Speed measurement and regulation of DC motor using armature control system |
| 2. | Speed regulation and torque measurement of AC Servomotor using armature control system |
| 3. | Modeling and performance analysis of stepper motor position control system |
| 4. | Performance analysis of BLDC motor control system and its parameter estimation |
| 5. | Step response analysis of second order system using Matlab |
| 6. | Installing ROS (Robotics operating system) and initializing catkin workspace |
| 7. | Creating an environment in Gazebo |
| 8. | Launching Turtlebots and manual mapping in Gazebo |
| 9. | Autonomous Navigation of Turtlebots in Gazebo |
| 10. | Implementing SLAM in custom environments |
| | **Total Laboratory Hours** \| **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | M. Gopal "Modern Control System Theory", 2014, 2nd ed. New Age International, NewDelhi, India. |
| | Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", 2nd Edition, Wiley Publisher, 2020. |

| **Reference Books** | | | | |
|---|---|---|---|---|
| 1. | M. Gopal,"Digital control and state variable methods", 2012, 4th ed., Tata McGraw Hill,USA. | | | |
| 2. | Webb & Reis, "Programmable Logic Controller - Principles and Applications", 2012, 5thed., PHI, New Delhi, India. | | | |
| 3. | I. J. Nagrath and M. Gopal, "Control Systems Engineering", 2017, 6th Ed., New AgeInternational (p) Limited. New Delhi, India. | | | |
| Mode of assessment: Continuous assessment / FAT / Oral examination and others | | | | |
| Recommended by Board of Studies | | 07-06-2023 | | |
| Approved by Academic Council | | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MEDS501L | Embedded System Design | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

The course aimed at

1. Ability to understand comprehensively the technologies and techniques underlying in building an embedded solution to a wearable, mobile and portable system.
2. Analyze UML diagrams and advanced Modelling schemes for different use cases.
3. Understand the building process of embedded systems

**Course Outcome**

The students will be able to

1. Define an embedded system and compare with general purpose system.
2. Appreciate the methods adapted for the development of a typical embedded system.
3. Get introduced to RTOS and related mechanisms.
4. Classify types of processors and memory architecture
5. Differentiate the features of components and networks in embedded systems
6. Develop real-time working prototypes of different small-scale and medium-scale embedded Systems.
7. Apprehend the various concepts in Multi-Tasking

| | | |
|---|---|---|
| **Module:1** | **Introduction to Embedded System** | **5 hours** |
| Embedded system processor, hardware unit, software embedded into a system, Example of an embedded system, Embedded Design life cycle, Layers of Embedded Systems. | | |
| **Module:2** | **Embedded System Design Methodologies** | **5 hours** |
| Embedded System modelling [FSM, SysML, MARTE], UML as Design tool, UML notation, Requirement Analysis and Use case Modelling, Design Examples | | |
| **Module:3** | **Building Process For Embedded Systems** | **4 hours** |
| Preprocessing, Compiling, Cross Compiling, Linking, Locating, Compiler Driver, Linker Map Files, Linker Scripts and scatter loading, Loading on the target, Embedded File System. | | |
| **Module:4** | **System design using general purpose processor** | **7 hours** |
| Microcontroller architectures ( RISC, CISC), Embedded Memory, Strategic selection of processor and memory, Memory Devices and their Characteristics, Cache Memory and Various mapping techniques, DMA. | | |
| **Module:5** | **Component Interfacing & Networks** | **9 hours** |
| Memory Interfacing, I/O Device Interfacing, Interrupt Controllers, Networks for Embedded systems- USB, PCI,PCI Express, UART, SPI, I2C, CAN, Wireless Applications - Bluetooth, Zigbee,Wi-Fi.,6LoWPAN , Evolution of Internet of things (IoT). | | |
| **Module:6** | **Operating Systems** | **7 hours** |
| Introduction to Operating Systems, Basic Features & Functions of an Operating System, Kernel & its Features [polled loop system, interrupt driven system, multi rate system], Processes/Task and its states, Process/Task Control Block, Threads, Scheduler, Dispatcher. | | |
| **Module:7** | **Multi Tasking** | **6 hours** |
| Context Switching , Scheduling and various Scheduling algorithms, Inter-process Communication (Shared Memory, Mail Box, Message Queue), Inter Task Synchronization (Semaphore, Mutex), Dead Lock, Priority Inversion (bounded and unbounded), Priority Ceiling Protocol & Priority Inheritance Protocol | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | | | |
|---|---|---|---|
| **Text Book(s)** | | | |
| 1. | Raj Kamal, “Embedded systems Architecture, Programming and Design”, Tata McGraw- Hill, 2016. | | |
| 2. | Wayne Wolf “Computers as components: Principles of Embedded Computing System Design”, The Morgan Kaufmann Series in Computer Architecture and Design, 2013. | | |
| **Reference Books** | | | |
| 1. | Lyla B. Das," Embedded Systems an Integrated Approach", Pearson Education, 2013. | | |
| 2. | Shibu K V," Introduction to Embedded Systems", McGraw Hill Education(India) Private Limited, 2014 | | |
| 3. | Sriram V Iyer, Pankaj Gupta " Embedded Real Time Systems Programming", Tata McGraw- Hill, 2012 | | |
| 4. | Steve Heath, “Embedded Systems Design”, EDN Series, 2013. | | |
| Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test | | | |
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MEDS601L | Electromagnetic Interference and Compatibility | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

The course is aimed at:

1. Imparting knowledge about EMI environment
2. Teaching EMI coupling principles, EMI control techniques and design of PCBs for EMC
3. Giving exposure to EMI Standards, Regulations and Measurements

**Course Outcomes**

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

1. Understand terminologies of EMI and EMC
2. Analyze and understand various EMI coupling mechanisms
3. List various EMI Test and Measurement methods
4. Analyze various techniques needed to suppress EMI
5. Perceive different EMC regulations followed worldwide
6. Ability to design an Electromagnetic Compatible systems.
7. Analyze and comprehend different techniques needed for Signal Integrity and ability to understand various models for EMI/EMC

| Module:1 | EMI Environment | 4 hours |
|---|---|---|

EMI-EMC Definitions and units of Parameters, Sources of EMI, conducted and radiated EMI, Transient EMI

| Module:2 | EMI Coupling Mechanisms | 6 hours |
|---|---|---|

Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply Coupling.

| Module:3 | EMI Test and Measurements | 8 hours |
|---|---|---|

EMI Specification / Standards / Limits: Units of specifications, Civilian standards Military standards. EMI Test Instruments / Systems, EMI Test, EMI Shielded Chamber, Open Area Test Site, TEM Cell Antennas, Conductors Sensors/Injectors/Couplers. EMI Measurement Methods: Military Test Method and Procedures, Calibration Procedures, Modeling interferences

| Module:4 | EMI Control Techniques | 7 hours |
|---|---|---|

Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting, Electrostatic discharge protection schemes

| Module:5 | EMC Standards and Regulations | 5 hours |
|---|---|---|

National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and RE standards, CISPR, CE and RE Standards, IEC/EN, CS standards, SAE Automotive EMC standard, Frequency assignment - spectrum conversation.

| Module:6 | System Design for EMC | 8 hours |
|---|---|---|

PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models,

| | | |
|---|---|---|
| System Enclosures, Power line filter placement, Interconnection and Number of Printed Circuit Boards, PCB and subsystem decoupling | | |
| **Module:7** | **Signal Integrity and EMI/EMC Models** | **5 hours** |
| Effect of terminations on line wave forms, Matching schemes for Signal Integrity, Effects of line discontinuities, Statistical EMI/EMC models. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| Guest Lectures from Industry and, Research and Development Organizations | | |
| | **Total Lecture hours:** | **30 hours** |
| **Text Book(s)** | | |
| 1. | Clayton R. Paul,IntroductiontoElectromagneticcompatibility,2010, 2nd edition., Wiley & Sons, New Jersey | |
| **Reference Books** | | |
| 1. | HenryW.ott, Electromagnetic Compatibility Engineering, 2011, 1sted. John Wiley and Sons, NewJersey. | |
| 2. | Patrick G. André and Kenneth Wyatt, EMI Troubleshooting Cookbook for Product Designers 2014, 1st ed., SciTech Publishing, New Jersey | |
| Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test | | |
| Recommended by Board of Studies | 07-06-2023 | |
| Approved by Academic Council | No. 70 | Date 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MEIC506L | Wireless Communications | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the different technologies in wireless communication systems.
2. To analyze the concepts of physical layer transmission techniques.
3. To Design and infer on next-generation wireless communication systems.

**Course Outcomes**

Students will be able to

1. Describe the evolution of different wireless communication systems and standards.
2. Analyze the mobile radio propagation, fading, and the channel modeling.
3. Interpret code division multiple-access techniques for wireless communications.
4. Apply the power and rate control methods in OFDM and OTFS.
5. Analyze the modern multi-antenna communication systems.
6. Explain the future wireless communications technologies.

| Module:1 | Evolution of Wireless Communications | 4 hours |
|---|---|---|

Introduction to wireless communications, Evolution of modern wireless communication systems- 2G/3G/4G/5G, Types of services, Requirement for the services, Spectrum limitations, Noise and interference limited systems, Multiple access schemes.

| Module:2 | Wireless Propagation Channels | 6 hours |
|---|---|---|

Large scale propagation-Propagation effects, Reflection, Diffraction and scattering, Free space propagation model, Two-ray ground reflection model, Log-distance path loss model, Log-normal shadowing, Outdoor propagation models, Okumura model, Hata model, COST-231, Link power budget analysis, Small Scale Propagation-Parameters of mobile multipath channels, Types of small scale fading, Rayleigh and Rician distributions, Jakes Doppler spectrum.

| Module:3 | Code-Division Multiple Access | 6 hours |
|---|---|---|

Introduction to CDMA, Mechanism, Spreading codes, Multi-user CDMA, Advantages of CDMA, CDMA forward and reverse channels, Soft handoff, CDMA features, Power control, Performance analysis of CDMA system.

| Module:4 | OFDM and OTFS | 8 hours |
|---|---|---|

Principle of orthogonal frequency division multiplexing (OFDM) - Implementation of transceivers, Cyclic prefix, Peak-to-Average Power Ratio (PAPR), Inter carrier interference, BER analysis of OFDM, Orthogonal time frequency spreading (OTFS), Signal representation, Implementation as overlay, Diversity and channel gain.

| Module:5 | Massive MIMO | 8 hours |
|---|---|---|

MIMO system model, MIMO Configurations - SISO, SIMO, MISO, MIMO, Diversity combining techniques, Selection combining (SC), Maximal Ratio Combining (MRC) and Switch-and-Stay Combining (SSC), Diversity gain, MIMO receivers – Zero-Forcing (ZF), Minimum Mean Square Error (MMSE), Coding techniques -Alamouti,

| | | |
|---|---|---|
| STBC, Beamforming techniques, Spatial Multiplexing, Multi-user MIMO-advantages and challenges, receivers, Massive MIMO- Channel model, Channel hardening, Matched filter receiver, Pilot contamination. | | |
| **Module:6** | **Key Wireless Communication Technologies** | **6 hours** |
| Cooperative communications-Fundamentals of Relaying, Relaying with Multiple and Parallel Relays, Applications. Device-to-Device Communications - Advanced Interference Processing, Non-orthogonal multiple access (NOMA)-Power domain, Code domain, Interference alignment, Radio wave propagation for mmWave - Large-scale and Small-scale propagation channel effects, Applications of mmWave Communications. | | |
| **Module:7** | **5G and B5G –New Radio** | **5 hours** |
| 5G System Overview - Physical Layer, Logical channels, Procedures - Carrier Aggregation and License-Assisted Access, Coordinated multipoint (CoMP), Dual Connectivity, and HetNet Support, Beyond 5G applications, Network Design, Spectrum Usage, Physical and MAC Layer Aspects, Real-Time Processing and RF Transceiver Design. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| Guest Lecture from Industries and R & D Organizations | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | Andreas F. Molisch, Wireless Communications: From Fundamentals to Beyond 5G, 2022, 3rd Edition, Wiley-IEEE Press. USA ISBN: 978-1-119-11720-9. |
| 2. | Feng Ouyang, Digital Communication for Practicing Engineers, 2019. 1st Edition, Wiley-IEEE Press, USA, ISBN: 978-1-119-41800-9. |
| **Reference Books** | |
| 1. | Suvra Sekhar Das, Ramjee Prasad. OTFS: orthogonal time frequency space modulation a waveform for 6G, 2021, River Publishers, Denmark, ISBN: 978-8770226561. |
| 2. | Emil Björnson, Jakob Hoydis and Luca Sanguinetti, Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency, 2017, Foundations and Trends® in Signal Processing, Now publishers, Netherlands, ISBN: 978-1-68083-985-2. |
| 3. | Theodore S. Rappaport, Robert W. Heath, Robert C. Daniels, James N. Murdock, Millimeter Wave Wireless Communications, 2021, 1st edition, Pearson, UK, ISBN-13: 9780132172288. |
| 4. | John W. Leis, Communication Systems Principles Using MATLAB, 2018, 1st Ed., Wiley-IEEE Press, USA, ISBN: 978-1-119-47067-0. |

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| Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test | | | |
| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS601L | Flexible and Wearable Sensors | 3 | 0 | 0 | 3 |
| Prerequisite: | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. To provide the overview of flexible electronics technology and the issues with materials processing for thin film electronics.
2. To expose the students for the materials selection and patterning methods for thin film electronics development.
3. 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.
4. 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.

**Course Outcome:**

1. Realize the technology developments in the flexible electronics technology.
2. Ability to identify the suitable materials and its processing for the development of thin filmelectronics
3. Ability to design the pattern and develop with suitable patterning methods.
4. Realize the process involved in the transformation of electronics from foils to textiles
5. Acquire the design knowledge for developing wearable sensors for physical and chemicalparameters
6. Gain the competency in transferring the conducting and semiconducting fibers to smarttextiles

| Module:1 | Overview of flexible electronics technology | 5 hours |
|---|---|---|

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.

| Module:2 | Amorphous and nano-crystalline silicon materials and Thin film transistors | 7 hours |
|---|---|---|

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.

| Module:3 | Materials and Novel patterning methods for flexible electronics | 7 hours |
|---|---|---|

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.

| Module:4 | Flexible electronics from foils to textiles | 6 hours |
|---|---|---|

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.

| Module:5 | Wearable haptics | 6 hours |
|---|---|---|

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.

| Module:6 | Wearable Bio, Chemical and Inertial sensors | 6 hours |
|---|---|---|

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|---|---|---|
| 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 | | |
| **Module:7** | **Knitted electronic textiles** | **6 hours** |
| 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. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

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. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1stEdition, Springer, New York.

**Reference Books**

1. Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementationand Applications", 2014, 1st Edition, Academic Press, Cambridge.

2. Kate Hartman, "Make: Wearable Electronics: Design, prototype, and wear your owninteractive garments", 2014, 1st Edition, Marker Media, Netherlands.

3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1stEdition, 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 Nano Technologies)', 2011, 1st Edition, William Andrew, New York.

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS603L | Chemical and Environmental Sensor | 3 | 0 | 0 | 3 |
| Pre-requisite: | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To extend engineering principles to electrochemical sensor development with a clearunderstating of oxidation and reduction of an electrolytic cell.
2. To propound the conception of ion selective and enzyme stabilized electrodes for thedetection of chemical and biomolecules.
3. To be expedient in applying specific interaction methods in the recognition of ion selectivegases using metal oxide based sensors.
4. Ability to analyze the modes of vibration and develop the suitable mass and thermalsensitive sensors.

**Course Outcomes**

1. Realize the need for half-cell and to analyze potential developed in any electrochemical cell.Apply the same for ion selective measurement
2. Be familiar with a wide range of chemical sensing methods and material characteristics tobe applied in biosensors.
3. Ability to design gas sensors for commercial and industrial applications.
4. Gain knowledge of nanomaterials for biological and medical applications
5. Able to discuss, develop and apply site specific antigen-antibody sensors design for mostcommon diseases like metabolic disorders
   Evaluate process design criteria for gas treatment and air quality analysis

| Module:1 | Electrochemistry | 7 hours |
|---|---|---|

Thermodynamics, , Enthalpy, Entropy, Gibbs free Energy, Law of Mass Action, simple Galvanic Cells, Electrode – Electrolyte Interface, Fluid Electrolytes, Dissociation of Salt, Solubility Product, Ion Product, pH Value, Ionic Conductivity, Ionic Mobility, Phase Diagrams.

| Module:2 | Transduction Principles | 6 hours |
|---|---|---|

Transduction Elements- Electrochemical Transducers-Introduction Potentiometry and Ion-Selective Electrodes: The Nernst Equation Voltametry and amperometry, conductivity, FET, Modified Electrodes, Thin-Film Electrodes and Screen-Printed electrodes, photometri sensors

| Module:3 | Chemical Sensing Elements | 6 hours |
|---|---|---|

Ionic recognition, molecular recognition-chemical recognition agent, spectroscopic recognition, biological recognition agents. Immobilization of biological components, performance factors of Urea Biosensors, Amino Acid Biosensors, Glucose Biosensors and Uric Acid, factors affecting theperformance of sensors.

| Module:4 | Potentiometric and Amperometric Sensors | 6 hours |
|---|---|---|

Potentiometric- Ion selective electrodes- pH linked, Ammonia linked, CO2 linked, Silver sulfide linked, Iodine selective, amperometric -bio sensors and gas sensors, Amperometric enzyme electrodes: substrate and enzyme activity, Detection mode and transduction method, mediated and modified electrodes, pH glass and ion selective electrodes, solid state and redox electrodes,

| Module:5 | Optical Biosensor and Immunosensors Biosensor | 6 hours |
|---|---|---|

Fiber optic biosensor, Fluorophore and chromophore based biosensor, Bioluminescence and chemiluminescence based biosensors, Non labled and labled

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| immune sensors, Microbial Biosensors: electrochemical, photomicrobial, Microbial thermistor. Application of microbial biosensors in glucose, ammonia, acetic acid, alcohol, BOD, methane sensing | | |
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| **Module:6** | **Sensors in exhaust gas treatment** | **6 hours** |
| Engine combustion process, Catalytic exhaust after treatment, Emission limits, Exhaust sensors and Enginecontrol, Emission test cycles, On-board diagnose (OBD): Diagnose Strategies, Exhaust sensors for OBD, Control Sensors: Hydro-Carbon Sensors, NOx-Sensors, Temperature Sensors, Oxygen Sensors. | | |
| | | |
| **Module:7** | **Measurement techniques for air quality** | **6 hours** |
| Measurement techniques for particulate matter in air. Specific gaseous pollutants analysis and control- Measurement of oxides of sulphur, oxides of nitrogen unburnt hydrocarbons, carbon-monoxide, dust mist and fog. | | |
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| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | Janata, Jiri,"Principles of Chemical sensors", 2014, 2nd edition, Springer, New York. |
| **Reference Book(s)** | |
| 1. | Brian R Eggins, “Chemical Sensors and Biosensors”, (Part of AnTS Series), 2010, 1stedition, John Wiley Sons Ltd, New York. |
| 2. | Peter Grundler, "Chemical Sensors: Introduction for Scientists and Engineers", 2011, 1stedition, Springer, New York. |
| 3. | R.G.Jackson, "Novel Sensors and Sensing", 2012, 1st edition, Philadelphia Institute ofPhysics. |
| 4. | Florinel-Gabriel Banica “Chemical Sensors and Biosensors: Fundamentals and Applications” 2012, 1st edition, Wiley-Blackwell, New Jersey. |
| 5. | M. Campbell, "Sensor Systems for Environmental Monitoring: Volume Two:Environmental Monitoring", 2011, 1st Edition, Springer, New York. |

Mode of Evaluation: CAT / Assignment / Quiz / FAT

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|---|---|---|---|
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS604L | Cloud and Fog Computing | 3 | 0 | 0 | 3 |
| Prerequisite | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives:**

The course is aimed to
1. Introduce cloud computing and enabling technologies
2. Explore the need for fog and edge computation
3. Impart the knowledge to log the sensor data and to perform further data analytics

**Course Outcome:**

At the end of the course student will be able to
1. Deploy their data in the cloud for simple applications
2. Apply the analytics in cloud to extract information
3. Appreciate and deploy fog data processing layers
4. Integrate sensor data to cloud through fog computation layers
5. Understand and implement edge computation
6. Develop edge analytics using python and tensor flow
7. Perform data pushing and processing in commercial clouds.

| Module 1 | Cloud Computing basics and enablingtechnologies | 7 hours |
|---|---|---|

Basics of cloud computing-Need for clouds- concepts and models: Roles and boundaries – Cloud characteristics – Cloud delivery models – Cloud deployment models. Broadband Networks and Internet Architecture – Data Center Technology – Virtualization Technology.

| Module 2 | Cloud Virtualisation | 6 hours |
|---|---|---|

Server oriented – Virtual Machines (IaaS), Modern Serverless Configurations- Functions/ (PaaS)Lambda functions – App, Biz function, logics, data ingestion (elasticity, scalability – on demand) DB services, Analytics services (SaaS).

| Module 3 | Cloud Application Development in Python | 6 hours |
|---|---|---|

Python for Cloud: Amazon Web Services – Google Cloud – Windows Azure. Python forMapReduce.

| Module 4 | Federated Cloud Service Management andIoT | 6 hours |
|---|---|---|

Cloud Service management (federated) –Cloud Life Cycle-service and management-Cloudarchitectures -Self organizing cloud architectures

| Module 5 | Fog computing | 6 hours |
|---|---|---|

Need for Fog computation, Fog data processing layers – Security and Identity Management – Business process integration – Big data interfaces – Wireless sensors and actuators, Fog in 5G, Architecture Harmonization Between Cloud Radio Access Networks and Fog Networks, Fog applications.

| Module 6 | Fog and edge computing | 6 hours |
|---|---|---|

Need for edge computation-Edge computing architectures,Device registration, Remote diagnostics,SW update, Geo distributed computing-concept of cloud orchestration, Edge Networks( Low bandwidth networks/ Security/ protcols),WAN vs Low bandwidth networks.

| Module 7 | Overview of Edge Data Analytics tools | 6 hours |
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Python advance libraries(Pandas, Scikit Learn), Tensor flow and Yolo

| Module 8 | Contemporary Issues | 2 hours |
|---|---|---|

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| | **Total Lecture:** | **45 hours** |
| **Text Books:** | | |
| 1. | Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, "Cloud Computing: Concepts,Technology & Architecture", Arcitura Education, 2013. | |
| 2. | Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-on Approach", 2013. | |
| 3. | Ovidiu Vermesan, Peter Friess, "Internet of Things – From Research and Innovation toMarket Deployment", River Publishers, 2014. | |
| 4. | Michael Missbach, Thorsten Staerk, Cameron Gardiner, Joshua McCloud, Robert Madl,Mark Tempes, George Anderson, "SAP on Cloud", Springer, 2016. | |
| 5 | John Mutumba Bilay , Peter Gutsche, Mandy Krimmel, Volker Stiehl , "SAP Cloud Platform Integration: The Comprehensive Guide", Rheinwerg publishing, 2nd edition, 2019, | |
| **Reference Books:** | | |
| 1. | Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012. | |
| 2. | S.-C. Hung et al.: Architecture Harmonization Between Cloud RANs and Fog Networks, IEEE Access: The Journal for rapid open access publishing, Vol.3, pp: 3019 – 3034, 2015. | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | |

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|---|---|---|---|
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS605L | IoT Security and Trust | 3 | 0 | 0 | 3 |
| Pre-Requisite: | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Objectives:**

To impart the knowledge and technical skills in designing secured and trustable IoT systems.

**Outcome:**

At the end of the course students will be able to

1. Design and implement cryptography algorithms using C programs
2. Solve network security problems in various networks
3. Build security systems using elementary blocks
4. Build Trustable cloud based IoT systems
5. Solve IoT security problems using light weight cryptography
6. Appreciate the need for cyber security laws and methods.

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| **Module 1** | **Fundamentals of encryption for cybersecurity.** | **7 hours** |

Cryptography – Need and the Mathematical basics- History of cryptography, symmetric ciphers, block ciphers, DES – AES. Public-key cryptography: RSA, Diffie-Hellman Algorithm,Elliptic Curve Cryptosystems, Algebraic structure, Triple Data Encryption Algorithm (TDEA) Blockcipher,

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| **Module 2** | **IoT security framework** | **6 hours** |

IIOT security frame work, Security in hardware,Bootprocess, OS & Kernel, application,run time environment and containers. Need and methods of Edge Security, Network Security: Internet, Intranet, LAN, Wireless Networks, Wireless cellular networks, Cellular Networks and VOIP.

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|---|---|---|
| **Module 3** | **Elementary blocks of IoT Security & Modelsfor Identity Management** | **6 Hours** |

Vulnerability of IoT and elementary blocks of IoT Security, Threat modeling – Key elements. Identity management Models and Identity management in IoT, Approaches using User-centric,Device-centric and Hybrid.

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|---|---|---|
| **Module 4** | **Identity Management and Trust Establishment** | **6 Hours** |

Trust management lifecycle, Identity and Trust, Web of trust models. Establishment: Cryptosystems – Mutual establishment phases – Comparison on security analysis. Identitymanagement framework.

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| **Module 5** | **Access Control in IoT and light weightcryptography** | **6 Hours** |

Capability-based access control schemes,Concepts, identity-based and identity-driven, Lightweight cryptography, need and methods , IoT use cases

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|---|---|---|
| **Module 6** | **Security and Digital Identity in CloudComputing** | **6 Hours** |

Cloud security , Digital identity management in cloud, Classical solutions, alternative solutions,Management of privacy and personal data in Cloud.

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|---|---|---|
| **Module 7** | **Cyber Crimes, Hackers and Forensics** | **6 Hours** |
| Cyber Crimes and Laws – Hackers – Dealing with the rise tide of Cyber Crimes – Cyber Forensicsand incident Response – Network Forensics. | | |
| | | |
| **Module:8** | **Contemporary Issues** | **2 Hours** |
| | | |
| | **Total Lecture:** | **45 Hours** |

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| **Text Books:** | |
| 1. | John R. Vacca, “Computer and Information Security Handbook”, Elsevier, 2013. Parikshit Narendra Mahalle , Poonam N. Railkar, “Identity Management for Internet of Things”, River Publishers, 2015. |
| 2. | William Stallings, “Cryptography and Network security: Principles and Practice”, 5th Edition, 2014, Pearson Education, India. |
| 3. | Maryline Laurent, Samia Bouzefrane, “Digital Identity Management”, Elsevier, 2015. |
| 4. | Joseph Migga Kizza, “Computer Network Security”, Springer, 2005. |
| **Reference Books:** | |
| 1. | Christof Paar and Jan Pelzl, “Understanding Cryptography – A Textbook for Students andPractitioners”, Springer, 2014. |
| 2. | Behrouz A.Forouzan : Cryptography & Network Security – The McGraw Hill Company,2007. |
| 3. | Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: “PrivateCommunication in a public World”, PTR Prentice Hall, Second Edition, 2002. |
| 4. | Alasdair Gilchrist, “IoT security Issues”, Oreilly publications, 2017. |

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|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS608L | RF and Microwave Sensors | 3 | 0 | 0 | 3 |
| Prerequisite: | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. To introduce the students with different RF and Microwave sensors,
2. To familiarize antenna design with a good understanding of their parameters andapplications.
3. To introduce comprehensive knowledge of wearable antenna.
4. To explore and understand basics of RFID technology.

**Course Outcome:**

1. Select a proper antenna design to be used in the RF spectral region
2. Model specific radiation pattern and evaluate them in different domains
3. Correlate the principle behind different radar systems and determine various applicationsbased on the radar systems.
4. Apply the basic knowledge in the measurement of RF radiation.
5. Gain knowledge about the RFID technology.

| Module:1 | RF Sensors | 6 hours |
|---|---|---|

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

| Module:2 | Antenna for personal area communication. | 6 hours |
|---|---|---|

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.

| Module:3 | Radar | 5 hours |
|---|---|---|

Introduction to RADAR, RADAR range equation, MTI and pulse Doppler RADAR, Tracking RADAR, SAR pulse RADAR, CW RADAR

| Module:4 | Applications of Radar | 6 hours |
|---|---|---|

Automotive, remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of RADAR, RADAR transmitters, Receivers,

| Module:5 | Radiometers | 6 hours |
|---|---|---|

Radiative transfer theory, SMMR, Types of radiometers - and Bolometers, Applications in automotive, agriculture, medicine, weather forecasting

| Module:6 | Microwave power Sensors | 6 hours |
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Diode Sensors: 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.

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| **Module:7** | **RFID Sensors** | **8 hours** |
| Introduction, Components of RFID systems, hardware and software components, RFID standards, RFID applications. | | |
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| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | Finkenzeuer Klaus, “RFID Handbook”, 2011, 3rd edition, John Wiley and Sons, New Jersey. |
| 2. | Constantine A. Balanis, “Antenna Theory Analysis and Design”, 2016, 4th edition, JohnWiley and Sons, New Jersey. |
| **Reference Books** | |
| 1. | B. Hoffman - Wellenhof, H.Lichtenegger and J.Collins, "GPS: Theory and Practice ", 5thedition, Springer, New York, 2012. |
| 2 | Lillesand & Kiefer, “Remote Sensing and Image Interpretation”, 2011, 6th edition, JohnWiley and Sons, New Jersey. |

Mode of Evaluation: CAT / Assignment / Quiz / FAT

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|---|---|---|---|
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS611L | Automotive Sensors and In-Vehicle Networking | 3 | 0 | 0 | 3 |
| Prerequisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. Acquaint with the basic automotive parts and the need for sensor integration in differentautomotive systems
2. Discuss the basics of various Power train sensors and associated systems for propervehicle dynamics and stability in Automotive systems.
3. Comprehend various sensors for vehicle body management and discuss various sensors and technologies for passenger convenience, safety and security systems.
4. Acquaint various communication standards and protocols followed within the automotivesystems.

**Course Outcome**

1. Identify and understand the basic automotive parts and the requirement of sensors andtheir integration in different automotive systems.
2. Discus and identify the basics of various Power train sensors.
3. Comprehend and analyse various systems like ABS, ESP, TCS, etc for understandingvehicle dynamics and stability.
4. Comprehend the various sensors for vehicle body management, convenience & securitysystems.
5. Identify various technologies developed for passenger convenience, Air Bag deploymentand Seat Belt Tensioner System, etc with the students
6. Recognize various communication standards and protocols followed within the automotivesystems.
7. Develop and create analytical designing of novel prototype models for various automotiveelectronic systems.

| Module:1 | Introduction to Automotive Engineering,Automotive Management systems | 7 hours |
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Power-train, Combustion Engines, Transmission, Differential Gear, Braking Systems, Introduction to Modern Automotive Systems and need for electronics in Automobiles, Application areas of electronics in the automobiles, Possibilities and challenges in the automotiveindustry, Enabling technologies and Industry trends.

| Module:2 | Power train Sensors | 6 hours |
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λ sensors, exhaust temperature sensor, NOx sensor, PM sensor, fuel quality sensor, level sensor,torque sensor, speed sensor, mass flow sensor, manifold pressure sensor.

| Module:3 | Sensors for Chassis management | 6 hours |
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Wheel speed sensors/direction sensors, steering position sensor (multi turn), acceleration sensor(inertia measurement), brake pneumatic pressure sensor, ABS sensor, electronic stability sensor.

| Module:4 | Sensors for vehicle body management, Sensors for automotive vehicle convenienceand security systems | 6 hours |
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Gas sensors ($CO_2$), Temperature/humidity sensor, air bag sensor, key less entering sensor, radar sensors. Tire pressure monitoring systems, Two wheeler and Four wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies, Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle

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| dynamics control, Accelerators and tilt sensors for sensing skidding and anti-collision, Anti-collision techniques using ultrasonic Doppler sensors. | | |
| **Module:5** | **Air Bag and Seat Belt Pre tensioner Systems** | **6 hours** |
| Principal Sensor Functions, Distributed Front Air Bag sensing systems, Single-Point Sensingsystems, Side-Impact Sensing, and Future Occupant Protection systems. | | |
| **Module:6** | **Passenger Convenience Systems** | **6 hours** |
| Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Tire Pressure Control Systems, Electromechanical Window Drives, etc. | | |
| **Module:7** | **Modern Trends and Technical Solutions** | **6 hours** |
| Enabling Connectivity by Networking:-In vehicle communication standards (CAN & LIN), Telematic solutions, Portable or embedded connectivity- Endorsing Dependability in Drive-by- wire systems:- Terminology and concepts , Why by-wire, FLEXRAY, Requirements on cost and dependability, Drive-by-wire case studies- prototype development-future of In vehicle communication. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total** | **45 hours** |
| **Text Book(s)** | | |
| 1. | Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5th Edition,BOSCH. | |
| 2. | John Turner, Automotive Sensors, 2010, 1st Edition, Momentum Press, New York. | |
| **Reference Books** | | |
| 1 | Automotive Sensors Handbook, 8th Edition, 2011, BOSCH. | |
| 2. | Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, IwaoYokomori, Sensors for AutomotiveTechnology, 2010, 4th Edition, Wiley, New York. | |
| 3. | Ernest O. Doebelin, “Measurement Systems – Application and Design”, 2017, 6th Edition,McGraw-Hill, New Delhi. | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | |
| Recommended by Board of Studies | 28-07-2022 | |
| Approved by Academic Council | No. 67 | Date 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS612L | Fiber Optic Sensors and Photonics | 3 | 0 | 0 | 3 |
| Prerequisite | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the theory and technology of fiber optics sensing to improve their understanding inrapidly growing field.
2. To predict the optical parameters in optical devices to understand the phenomena induced due tointensity based effects.
3. To estimate the phase, charge distribution due to polarization effects and its application inoptical sensing.
4. To analyses and decide the process flow conditions and steps involved for different polymerswith appropriate optical characteristic for polymer waveguides based sensing.

**Course Outcomes**

1. Attainment of basic knowledge of optical waveguides and optical devices employed in opticalsensors.
2. Will be conversance in optical parameters involved in active and passive components
3. Entrust the characteristics of a suitable optical materials for the sensing device in a givenapplication.
4. Identify and apply the knowledge in designing interferometric devices which is more effectivelyused in sensing.
5. Will be aware of different polymers and their chemical, optical characteristics to formulateminiaturized optical devices.

| Module:1 | Theory of Optical Waveguides | 7 hours |
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Wave theory of optical waveguides, formation of guided modes, Slab waveguide, Rectangular waveguide, Radiation fields from waveguide, Effective index method, Marcatili's method, Beam propagation method. Basic characteristic of Optical Fiber Waveguides, Acceptance angle, Numericalaperture, skewrays- Electromagnetic Modes in Cylindrical Waveguides.

| Module:2 | Active and Passive Optical Components | 7 hours |
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Electro-optic and acousto optic wave guide devices, directional couplers, optical switch, phase and amplitude modulators, filters etc. Yjunction, powersplitters, arrayed wave guide devices, fiber pigtaling, end-fiber prism coupling, FBG and fabrication of FBG, Tapered couplers.

| Module:3 | Intensity and Polarization Sensors | 7 hours |
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Intensity sensor: Transmissive concept –Reflective concept-Micro bending concept– Transmission and Reflection with other optic effect-Interferometers –Mach Zehnder-Michelson-Fabry-Perot and Sagnac– Phase sensor: Phase detection-Polarization maintaining fibers. Displacement and temperature sensors: reflective and Micro bending Technology- Applications of displacement and temperature sensors.

| Module:4 | Interferometric Sensors | 7 hours |
|---|---|---|

Pressure sensors: Transmissive concepts, Microbending –Intrinsic concepts– Interferometric concepts, Applications. Flow sensors: Turbine flowmeters- Differential pressure flowsensors –Laser Doppler velocity sensors-Applications- Sagnac Interferometer for rotation sensing. Magnetic and electric fieldsensors: Intensity and phase modulation types– applications.

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| **Module:5** | **Polymer based waveguide in sensing** | **7 hours** |
| Polymer based waveguide, materials, properties, fabrication process of polymer based waveguide, Polymer based optical components - Passive, Active polymer devices, Ring Resonator, structure, theory,Filter using Ring Resonator-application in sensing | | |
| **Module:6** | **Fiber based Chemical Senors** | **5 hours** |
| Fiber based Chemical Sensing: Absorption, Fluorescence, Chemi-luminescence, Vibrational Spectroscopic, SPR. | | |
| **Module:7** | **Fiber based Bio-Senors** | **3 hours** |
| Fiber based Bio-molecules sensing: High Index, SPR, Hollow core fiber probes, Label Free bio- molecules. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| **Total Lecture hours:** | | **45 hours** |

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| **Text Book(s):** | |
| 1. | David A. Krohn, Trevor W. MacDougall, Alexis Mendez, "Fiber Optic Sensors: Fundamentals and Applications" SPIE Press, 4th ed. 2015. ISBN: 1628411805 |
| 2. | Eric Udd , William B. Spillman Jr., "Fiber Optic Sensors: An Introduction for Engineersand Scientists", Wiley, 2nd Ed., 2011. ISBN: 0470126841 |
| **Reference Book(s)** | |
| 1. | Zujie Fang & et. al., "Fundamentals of Optical Fiber Sensors" Wiley, 1st Ed., 2012.ISBN:0470575409 |
| 2 | Shizhuo Yin, Paul B. Ruffin, and Francis T.S. Yu, "Fiber Optic Sensors",CRC Press, 2 Ed,2017. ASIN: B078JN75QW |
| 3 | F.Baldini&et.al.,"Optical Chemical Sensors", NATO Science Series II: Mathematics,Physics and Chemistry, Springer, 2008. ISBN: 1402046103 |

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| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 28-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS614L | Deep Learning | 3 | 0 | 0 | 3 |
| Prerequisite: | NIL | Syllabus Version | | | |
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**Course Objectives**

1. To introduce the fundamental theory and concepts of machine learning and artificial intelligence
2. To provide a comprehensive foundation to artificial neural networks, neuro-modeling, and their applications to pattern recognition.
3. To explore the learning paradigms of supervised and unsupervised shallow/deep neural networks.
4. To provide exposure to the recent advances in the field of and facilitate in depth discussionson chosen topic
5. To impart adequate knowledge on deep learning frameworks and their applications to solvingengineering problems

**Course Outcomes**

1. Gain knowledge about basic concepts of machine learning algorithms and identify machinelearning techniques suitable for the given problem.
2. Understand the differences between shallow neural networks and deep neural networks forsupervised and unsupervised learning.
3. Develop and train neural networks for classification, regression and clustering.
4. Understand the foundations of neural networks, how to build neural networks and learn how to leadsuccessful machine learning projects
5. Identify the deep feed forward, convolution and recurrent neural networks which are moreappropriate for various types of learning tasks in various domains
6. Implement deep learning algorithm and solve real world problems

| Module:1 | Foundations of Machine Learning-I | 5 hours |
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Supervised and unsupervised learning, parametric vs non-parametric models, parametric models for classification and regression- Linear Regression, Logistic Regression, Naïve Bayes classifier, simple non-parametric classifier-K-nearest neighbour, support vector machines.

| Module:2 | Foundations of Machine Learning-II | 5 hours |
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Clustering- distance based- K-means, density based, association rule mining, validation techniques- cross validations, feature selection and dimensionality reduction, principal component analysis-Eigenvalues, Eigen vectors, Orthogonality-challenges motivating deep learning

| Module:3 | Neural Networks for Classification and Regression | 6 hours |
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ANN as a technique for regression and classification, structure of an artificial neuron, activation functions- linear activation, sigmoid and softmax. Feedforward neural networks- shallow model-single layer perceptron, multi-layer perceptron as complex decision classifier- learning XOR-Gradient based learning, Backpropagation algorithm, risk minimization, loss function, regularization, heuristicsfor faster training and avoiding local minima.

| Module:4 | Deep Feed Forward Neural Networks | 6 hours |
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Feed forward neural networks- deep model- output units and hidden units, training deep models- hyper parameters and validation sets-cross validation, capacity, overfitting and under fitting, bias vs variance trade off, cross validation - vanishing

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| gradient problem, new optimization methods (adagrad, adadelta, rmsprop, adam), regularization methods (dropout, batch normalization, dataset augmentation), early stopping. | | |
| **Module:5** | **Convolutional Neural Networks** | **7 hours** |
| Convolution operation- kernel and feature map, sparse connectivity, equivariance through parameter sharing, pooling function for invariant representation, convolution and pooling as strong prior, convolution with stride, effect of zero padding, single-channel and multi-channel data types used in ConvNet, variants of basic convolution- locally connected, tiled ConvNet- spatial separable and depthwise separable convolutions, fully connected layers, ConvNet architecture-layer patterns, layer sizing parameters, case studies- - LeNet, AlexNet | | |
| **Module:6** | **Recurrent Neural Networks** | **6 hours** |
| Sequence learning with neural nets, unrolling the recurrence, training RNN-Back projection through time (BPTT), vanishing gradient problem, Gated recurrent unit (GRU), Long short term memory (LSTM), Bidirectional LSTMs, bidirectional RNNs | | |
| **Module:7** | **Deep Learning Tools and Applications** | **8 hours** |
| Tools:TensorFlow, Keras, PyTorch, Caffe, Theano, MXNet. Applications: Object detection with RCNN - YOLO, SSD. Speech recognition with RNN. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| **Total Hours** | | **45 hours** |

| **Text Book(s)** | |
|---|---|
| 1 | Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning" 2015, MITPress |
| 2 | Josh Patterson and Adam Gibson, "Deep Learning- A Practitioner's Approach"O'Reilly Media Inc., 2017, USA. |
| **Reference Books** | |
| 1. | Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2011 |
| 2 | Rich E and Knight K, "Artificial Intelligence", 2011, 2nd ed., TMH, New Delhi, |
| 3 | Bengio, Yoshua. "Learning deep architectures for AI- Foundations and trends inMachine Learning, 2(1)- 2009 |
| 4 | Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (India) Pvt Ltd, 2013. |

Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.

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| Recommended by Board of Studies | 07-06-2023 | | |
| Approved by Academic Council | No. 70 | Date | 24-06-2023 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MITS615L | Web Design and Development | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. To acquire specific scripting knowledge to develop interactive applications.
2. To understand the basics of android application development.
3. To apply the programming skills in developing application pertaining to Industrial, medical, agricultural, etc.

**Course Outcomes:**

1. Design dynamic web forms to acquire and process user & sensor data
2. Interactive forms using Java Script with a focus on internet of things
3. Implement mobile application using android SDK
4. Solve the need for smart systems in a distributed environment
5. Understand the IoT architecture and building blocks for various domains
6. Devise multidisciplinary case to case modelling and execute wide range of application

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| **Module:1** | **Markup Language** | **7 hours** |

Introduction to Markup language, HTML document structure, HTML forms, Style (CSS), Multiple CSS stylesheets, DHTML, Tools for image creation and manipulation, User experience design, IoT development using charts

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| **Module:2** | **Scripting Language** | **6 hours** |

Introduction to JavaScript, Functions, DOM, Forms, and Event Handlers, Object Handlers, Input validation, J2ME, application design using J2ME, IoT development using Real time rules, platforms, alerts

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| **Module:3** | **Android Programing Framework** | **6 hours** |

Mobile app development: Android Development environment, Simple UI Layouts and layout properties, GUI objects, Event Driven Programming, opening and closing a Database

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| **Module:4** | **Industrial Internet Application** | **6 hours** |

IIoT Fundamentals and Components, Industrial Manufacturing, Monitoring, Control, Optimization and Autonomy, Introduction to Hadoop and big data analytics

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| **Module:5** | **Applications in agriculture** | **6 hours** |

Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides.

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| **Module:6** | **Applications in IoT enabled Smart Cities** | **6 hours** |

Energy Consumption Monitoring, Smart Energy Meters, Home automation, SmartGrid and Solar Energy Harvesting, Intelligent Parking, Data lake services scenarios.

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| **Module:7** | **Healthcare applications** | **6 hours** |

Architecture of IoT for Healthcare, Multiple views coalescence, SBC-ADL to construct the system architecture. Use Cases: Wearable devices for Remote monitoring of

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| Physiologicalparameter, ECG, EEG, Diabetes and Blood Pressure. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| **Text Book(s)** | | |
| 1. | John Dean, Web Programming with HTML5, CSS and JavaScript, 2018, Jonesand Bartlett Publishers Inc., ISBN-10: 9781284091793 | |
| 2. | DiMarzio J. F., Beginning Android Programming with Android Studio, 2016, 4th ed.,Wiley, ISBN-10: 9788126565580 | |
| **Reference Books** | | |
| 1. | Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRCPress,ISBN-10: 1138316849 | |
| 2. | Giacomo Veneri, and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, 2018, Packt Publishing. | |
| 3. | Subhas Chandra Mukhopadhyay, Smart Sensing Technology for Agriculture andEnvironmental Monitoring, 2012, Springer, ISBN-10: 3642276377 | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | |
| Recommended by Board of Studies | 07-06-2023 | |
| Approved by Academic Council | No. 70 | Date 24-06-2023 |