SCHOOL OF ELECTRONICS ENGINEERING

M. Tech Internet of Things & Sensor Systems
(M.Tech MTS)

Curriculum
(2019-2020 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_03: 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_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information.

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice.

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems.

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development.

PO_08: Having a clear understanding of professional and ethical responsibility.

PO_11: Having a good cognitive load management skills related to project management and finance.
M. Tech Internet of Things & Sensor Systems

ADDITIONAL PROGRAMME OUTCOMES (APOs)

APO_02: Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified)

APO_03: Having design thinking capability

APO_04: Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning

APO_07: Having critical thinking and innovative skills

APO_08: Having a good digital footprint
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.
M. Tech Internet of Things & Sensor Systems

CREDIT STRUCTURE

Category-wise Credit distribution

<table>
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## M. Tech Internet of Things & Sensor Systems

### DETAILED CURRICULUM

#### University Core

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Pre-requisite Nil

Syllabus version 1.0

**Course Objectives:**

1. To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterised, and analysed.
2. To introduce the students to sources and detectors of various Optical sensing mechanisms and 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 of sensor 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

**Expected Outcomes:**

1. Use concepts in common methods for converting a physical parameter into an electrical quantity
2. Choose an appropriate sensor comparing different standards and guidelines to make sensitive 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 their importance
6. Create analytical design and development solutions for sensors.
7. Compete in the design, construction, and execution of systems for measuring physical quantities

**Student Learning Outcomes (SLO):** 1, 5, 14

**Module:1** | Sensor fundamentals and characteristics 2 hours
Sensor Classification, Performance and Types, Error Analysis characteristics

**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, Photo diodes, 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 5 hours
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

**Module:5** | Position, Direction, Displacement and Level 4 hours
sensors

Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magnetostriective sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. Signal condition circuits for reactive and self generating sensors.

Module:6  Velocity and Acceleration sensors  3 hours

Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes.

Module:7  Flow, Temperature and Acoustic sensors  6 hours


Module:8  Contemporary Issues  2 hours

Text Book(s)


Reference Books


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

List of Experiments:  (Indicative)

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 a range of 0-5 Kg with a sensitivity of 5 mg. What modification he/she has to do to change 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

3. After studying the characteristics of temperature sensors listed below, develop a
temperature measurement system for a particular application using the suitable sensor.

- i. Thermocouple principles
- ii. Thermistor and linearization of NTC Thermistor
- iii. Resistance Temperature Detector
- iv. Semiconductor Temperature sensor OA79
- 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.

| Total Laboratory hours | 30hours |

Mode of Evaluation: Continuous Assessment and FAT

Recommended by Board of Studies | 26-06-2019
Approved by Academic Council | No. 55 | Date | 13-06-2019
Course code | Course title | L | T | P | J | C | Syllabus version
--- | --- | --- | --- | --- | --- | --- | ---
ECE5061 | IoT Fundamentals and Architecture | 3 | 0 | 0 | 0 | 3 | v. 1.00

Pre-requisite Nil

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 IoT platforms.
4. Make the students to apply IoT data for business solution in various domain in secured manner.

Expected Course Outcome:
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.

Student Learning Outcomes (SLO): [5,6,14]

Module: 1 | Evolution of IoT | 7 hours
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Module: 2 | Introduction to IoT components | 6 hours
--- | --- | ---
Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, 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
--- | --- | ---
IoTCommunicationPattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE, SIG, NFC, LORA, Lifi, Widi)

Module: 5 | Introduction to Cloud computation and Big data analytics | 6 hours
--- | --- | ---
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 | 6 hours
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Need for encryption, standard encryption protocol, light weight cryptography, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security

Module: 7 | IoT application and its Variants. | 6 hours
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**Case studies:** IoT for smart cities, health care, agriculture, smart meters, M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards.

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**Text Book(s)**


**Reference Books**


**Mode of Evaluation:** CAT / Assignment / Quiz / FAT / Project / Seminar

**Recommended by Board of Studies:** 26-04-2019

**Approved by Academic Council:** No. 55 Date 13-06-2019
Course Code | Course Title | L | T | P | J | C | Syllabus Version
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ECE5062 | DATA ACQUISITION | 0 | 0 | 4 | 0 | 2 | 1.0

**Course Objectives:**

1. To explore the fundamentals of data acquisition using sensors, NI data acquisition hardware, and LabVIEW.
2. To teach the basics of hardware selection, including resolution and sample rate, and the foundation of sensor connectivity, including grounding and wiring configurations.
3. To provide knowledge on using the NI-DAQmx driver to measure, generate, and synchronize data acquisition tasks and analyze the data in MATLAB/ LabVIEW.
4. To impart adequate knowledge on programming finite and continuous acquisitions, as well as best practices in hardware/software timing, triggering, and logging.
5. To give hands-on experience configuring and programming NI data acquisition hardware using NI-DAQmx and LabVIEW.

**Course Outcomes:**

1. Develop PC-based data acquisition and signal conditioning.
2. Understand how to control the analog input, analog output, counter/timer, and digital I/O subsystems of a DAQ device.
3. 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.
4. Acquire data from sensors, such as thermocouples and strain gages, using NI DAQ hardware and analyse the results in LabVIEW and MATLAB.
5. Apply advanced understanding of LabVIEW and the NI-DAQmx API to create applications.

**Student Learning Outcomes (SLO):**

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<td>LabVIEW Graphical Programming, NI DAQmx, Data acquisition Toolbox to read data into MATLAB and Simulink and write data into DAQ device.</td>
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<td>Simultaneous and synchronized data acquisition</td>
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<td>Arduino based multi-channel data acquisition</td>
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<td>Remote data acquisition with NI WSN Gateway and nodes, CC3200 (WiFi)</td>
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| Total Practical Hours | 60 hours |

**Text Book(s)**

**Reference Book(s)**

Mode of Evaluation: Continuous Assessment and FAT

Recommended by Board of Studies: 26/04/2019
Approved by Academic Council: 55 Date: 13/06/2019
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**Prerequisite:** Nil

**Course Objectives:**
- To impart knowledge on performance specification, limitations and structure of controllers
- To impart knowledge on design of controllers using root-locus and frequency domain techniques

**Course Outcome**
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.

**Text Book(s)**

**Reference Book(s)**

**List of Experiments:** (Through Inlab/Remotelab)
1. Introduction to real time controller system operations 4 hours
2. Speed regulation measurement of DC motor using armature control system 4 hours
3. Speed regulation and torque measurement of AC Servomotor using armature control system 4 hours
4. Modeling and performance analysis of stepper motor position control system 4 hours
5. Performance analysis of BLDC motor control system and its parameter estimation 4 hours
6. ON/OFF temperature control system using LabVIEW platform 4 hours
<table>
<thead>
<tr>
<th></th>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Step response analysis of second order system using Matlab</td>
<td>4 hours</td>
</tr>
<tr>
<td>8</td>
<td>Frequency response analysis of LEAD/LAG compensating network</td>
<td>6 hours</td>
</tr>
<tr>
<td>9</td>
<td>Temperature control of a plant using PID controller with LabVIEW platform/MSP430</td>
<td>6 hours</td>
</tr>
<tr>
<td>10</td>
<td>Modelling and implementation of level control system using PLC</td>
<td>6 hours</td>
</tr>
</tbody>
</table>
|11 | Modelling and implementation of  
a. Speed regulation of servo motor using Fuzzy logic controller with Matlab/MSP430  
b. Water level controller using Fuzzy logic controller  
c. Comparison of plant performance with PID vs Fuzzy logic controller                  | 6 hours  |
|12 | (a) Vertical take-off and landing system- Modelling, Current Control & Flight Control  
(b) Inverted pendulum control system: Modelling Balance Control design & Up control  
c. HVAC system (Quanser NI Elvis): On-off Control, PI Control  
d. DC motor speed control (Quanser NI Evis) : Modelling, Speed Control & Position Control. | 8 hours  |

**Total Laboratory Hours**  60 hours

Mode of Evaluation: Continuous Assessment  LabCAT and LabFAT

Recommended by Board of Studies  No. 55  Date  13-06-2019
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>J</th>
<th>C</th>
<th>Syllabus Version</th>
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<tbody>
<tr>
<td>ECE5064</td>
<td>Programming and scripting languages</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>1.0</td>
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</tbody>
</table>

Prerequisite: Nil

Course Objectives:
1. To expose the students to the fundamentals of embedded Programming.
2. To Introduce the GNU C, C++ Programming Tool Chain in Linux.
3. To study the basic programming of Python and R.

Expected Outcomes:
The students will be able to
1. Solve problems using C
2. Appreciate and apply C++
3. Perform tasks using linux scripts.
4. Understanding the basic concepts of process and IPC mechanisms
5. Program R for simple data oriented applications

<table>
<thead>
<tr>
<th>Task 1</th>
<th>Embedded Programming</th>
<th>12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C programming,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Declarations and</td>
<td></td>
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<tr>
<td></td>
<td>Expressions, Arrays,</td>
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<tr>
<td></td>
<td>Pointers, Constructs,</td>
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</tr>
<tr>
<td></td>
<td>Data structures and</td>
<td></td>
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<tr>
<td></td>
<td>Linked list, Embedded</td>
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<td></td>
<td>C (Keil).</td>
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<thead>
<tr>
<th>Task 2</th>
<th>C++ Programming</th>
<th>12 hours</th>
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<tbody>
<tr>
<td></td>
<td>Programs for class,</td>
<td></td>
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<tr>
<td></td>
<td>objects, member</td>
<td></td>
</tr>
<tr>
<td></td>
<td>functions, access</td>
<td></td>
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<tr>
<td></td>
<td>modifiers, OOPS</td>
<td></td>
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<tr>
<td></td>
<td>encapsulation,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inheritance</td>
<td></td>
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<tr>
<td></td>
<td>polymorphism</td>
<td></td>
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<tr>
<td></td>
<td>functions, constructors,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and destructors</td>
<td></td>
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<tr>
<td></td>
<td>Stream class to</td>
<td></td>
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<tr>
<td></td>
<td>perform File input-</td>
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<tr>
<td></td>
<td>output</td>
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<table>
<thead>
<tr>
<th>Task 3</th>
<th>Python Programming</th>
<th>12 hours</th>
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<tbody>
<tr>
<td></td>
<td>Basic operations, String manipulation, Dictionary, Signal plotting and processing, Graphics</td>
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<thead>
<tr>
<th>Task 4</th>
<th>Linux</th>
<th>6 hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Shell programming, Regular expression, Process creation, Inter process communication</td>
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<thead>
<tr>
<th>Task 5</th>
<th>R programming</th>
<th>2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data types, Data plotting ,analysis and regression, Machine intelligence</td>
<td></td>
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</tbody>
</table>

Text Book(s)

Mode of Evaluation: Continuous Assessment and FAT

Recommended by Board of Studies
Approved by Academic Council
No. 55
Date
26/04/2019
13/06/2019
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>ECE5065</td>
<td>MICROCONTROLLERS FOR IOT PROTOTYPING</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
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<td>Prerequisite:</td>
<td>Nil</td>
<td></td>
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</tbody>
</table>

**Course Objectives:** The course is aimed to

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 (CO):** At the end of the course the student should be able to

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.

**Student Learning Outcomes (SLO):** 5,6,14

**Module:1  MSP430 microcontrollers** 6 hours

**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, Advanced Cortex MX Microcontroller, core, architecture, on-chip wi-fi.

**Module:3  Display and Communication modules** 4 hours
GPIO, LCD display, graphical display, relays, Peripheral programming SPI, I2C, UART, Zigbee controller.

**Module:4  Sensors interfacing** 4 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** 2 hours
ESP8266, NodeMCU, TI-CC3200, Access point and station point mode, HTTP, MQTT, transmission and receiving, Intel-Galileo boards.

<table>
<thead>
<tr>
<th>Module: 6</th>
<th>Single board computers</th>
<th>4 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry pi board, porting Raspbian, sensor interface examples, Python programming for cloud access, sensor systems using Arduino boards</td>
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</table>

<table>
<thead>
<tr>
<th>Module: 7</th>
<th>Cloud interfacing</th>
<th>2 hours</th>
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<tbody>
<tr>
<td>Interfacing and data logging with cloud: Thing speak, Things board, Blynec platform.</td>
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</table>

<table>
<thead>
<tr>
<th>Module: 8</th>
<th>Contemporary Issues</th>
<th>2 hours</th>
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<thead>
<tr>
<th>Text Book(s)</th>
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<table>
<thead>
<tr>
<th>Reference Book(s)</th>
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| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects, Hackathon/Makeathon and FAT. |

<table>
<thead>
<tr>
<th>List of Experiments: (Indicative)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1. Working with MSP430 (CCStudio)</td>
<td>6 hours</td>
</tr>
<tr>
<td>- Sub Task 1: Port programming of MSP430 microcontrollers</td>
<td></td>
</tr>
<tr>
<td>- Sub Task 2: Analog to Digital Conversion using MSP430 microcontroller</td>
<td></td>
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<tr>
<td>- Sub Task 3: LCD display of characters and numbers.</td>
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<tr>
<td>- Sub Task 4: Timer</td>
<td></td>
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<tr>
<td>2. Working with ARM (Keil and energia)</td>
<td>8 hours</td>
</tr>
<tr>
<td>- Sub Task 1: Peripheral programming of ARM7 board</td>
<td></td>
</tr>
<tr>
<td>- Sub Task 2: PWM generation</td>
<td></td>
</tr>
<tr>
<td>- Sub Task 3: Configuring CC3200, wifi configuration, HTTP and MQTT Protocol</td>
<td></td>
</tr>
<tr>
<td>3. Low power wireless transmission using Zigbee</td>
<td>8 hours</td>
</tr>
<tr>
<td>- Sub Task 1: Interfacing Zigbee controller with MSP 430 microcontroller using SPI/UART.</td>
<td></td>
</tr>
<tr>
<td>- Sub Task 2: Programming sleep and wake up mode of MSP 430.</td>
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</tr>
<tr>
<td>4. IoT systems</td>
<td>8 hours</td>
</tr>
<tr>
<td>- Arduino platform</td>
<td></td>
</tr>
<tr>
<td>- Working with open source clouds</td>
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</tr>
</tbody>
</table>
Recommended by Board of Studies 26/04/2019
Approved by Academic Council 55 Date 13/06/2019

Course Code | Course Title | L | T | P | J | C
---|---|---|---|---|---|---
ECE6001 | WIRELESS SENSOR NETWORKS AND IoT | 2 | 0 | 0 | 4 | 3
Pre-requisite | ECE 5061- IoT Fundamentals and Architecture | 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 WSN application.
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 data transmission 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 sensor network applications.
6. Familiarize the protocol, design requirements, suitable algorithms, and the state-of-the-art cloud platform to meet the industrial requirement.
7. On a profound level to implement hardware & software for wireless sensor networks in day to day life

SLO : 5,6,7

Module:1 | Network for embedded systems | 3 hours
---|---|---
RS232, RS485, SPI, I2C, CAN, LIN, FLEXRAY.

Module:2 | Embedded wireless communication and Protocols | 5 hours
---|---|---
Bluetooth, Zigbee, Wifi, MiWi, Nrf24, Wireless LAN &PAN, UWB

Module:3 | Wireless sensor network (WSN) | 4 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.

<table>
<thead>
<tr>
<th>Module:4</th>
<th>WSN (Medium access control)</th>
<th>5 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts, Contention Based protocols, Schedule-based protocols - SMAC – BMAC, Traffic-adaptive medium access protocol (TRAMA), The IEEE 802.15.4 MAC protocol.</td>
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</table>

<table>
<thead>
<tr>
<th>Module:5</th>
<th>Sensor Network Architecture</th>
<th>5 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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, WSN and Internet Communication, WSN Tunneling</td>
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</table>

<table>
<thead>
<tr>
<th>Module:6</th>
<th>IP based WSN</th>
<th>4 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Circuit switching, packet switching, concept of IPV4, IPV6, 6LOWPAN and IP, IP based WSN, 6LOWPAN based WSN.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module:7</th>
<th>Tiny OS</th>
<th>2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tiny OS for WSN and IoT, M2M communication, Alljoyn network</td>
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</table>

<table>
<thead>
<tr>
<th>Module:8</th>
<th>Contemporary issues</th>
<th>2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Lecture hours: 30 hours</td>
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</tbody>
</table>

Text Book(s):


Reference Book(s)


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

List of Projects: (Indicative) 15 Hours

1. Smart door locks offer sophisticated "access control" features to any home or business. Proximity sensors like Bluetooth and NFC can enable a door to unlock whenever an authorized user's smartphone approaches. Users can also remotely lock and unlock the door, or share access with any number of others, using mobile apps. Keeping the above design parameters implement a Smart locks for apartment’s security using IoT principle.

2. The refrigerator is the most frequently used domiciliary/kitchen electrical appliance all over the world for food storage. Implement a Smart refrigeration module designed to convert any existing normal
refrigerator into a smart and low-cost machine using sensors. Smart refrigerator compares the status of the food for e.g. weight, quantity etc. The smart refrigerator must also be remotely controlled and notifies the user about scarce products via wifi module (internet) on user’s mobile android application. Add functionality which includes the ice ready indication, power saving, smell detection, overweighting etc.

3. Water has become a scarce resource and is crucial to the production of food. Therefore, design and implement a wireless sensor network to manage and conserve this vital resource. Part of the system includes the design and development of three sensor nodes to monitor soil moisture. An interface to display and store the status of the water content and also to be uploaded to a web server.

4. Design and provide necessary modules and service, such as command dissemination, feedback module, data logging and collection module, network programming module and time synchronization service between different sensor nodes.

5. WSN has a variety of services based on sensor network architecture. Common issues such as network bandwidth reduction, collision occurrence and performance deterioration due to the broadcasting of message in large-scale networks have become main challenges. To overcome these issues implement routing algorithm based on data-centric routing and address-based routing schemes, by which the query messages are delivered to the target area by using address-based routing scheme, then, the broadcast scheme.

Mode of Evaluation: Review I, II, III

<table>
<thead>
<tr>
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<th>26/04/2019</th>
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<tbody>
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<td>No. 55</td>
</tr>
<tr>
<td>Date</td>
<td>13/06/2019</td>
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</tbody>
</table>
Course Code: ECE6030  
Course Title: SIGNAL PROCESSING AND DATA ANALYTICS  
L T P J C: 2 0 2 0 3  
Pre-requisite: ECE5062 - Data Acquisition  
Syllabus version: v.1

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

Expected Course Outcomes:
1. Apply FFT, DCT wavelet techniques for extracting the features from the big data.
2. Develop algorithms that can be used to analyze the real-world univariate and multivariate time 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 detect and characterize patterns in real-world data.
5. Estimate the signal parameters and identify the model using ARMA models and prediction filters.
6. Understand the methods of visualization and analysis of big data.

Student Learning Outcomes (SLO): 7,14,17

Module: 1 Discrete Random Signal Processing  4 hours

Module: 2 Signal Modeling  4 hours
ARMA, AR, MA Models. Wiener filter, Linear prediction, Kalman Filter.

Module: 3 Feature extraction  4 hours
FFT, Power spectrum, DCT, filter banks, Wavelet, Wavelet Packets, Cepstrum

Module: 4 Time series analysis  4 hours
Basic analysis, Univariate time series analysis, Multivariate time series analysis, non stationary time series.

Module: 5 Reduction of dimensionality  4 hours
Bayesian decision, Linear discrimination, Principal Component analysis, SVD, Independent Component Analysis.
Module: 6  |  Machine learning  |  4 hours  
Supervised learning, generative algorithms, Support Vector machines, Unsupervised learning, K means clustering, Neural network (SOM, ART), Expectation maximization.

Module: 7  |  Big Data Analytics  |  4 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:  |  30 hours  

Text Book(s)

Reference Books

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

List of Challenging Experiments (Indicative)
1. Design and implementation of Wiener filter and Kalman filter.  
2. Design and implementation of filter banks and wavelets for random process (speech, audio).  
3. Design and implementation of Principal Component Analysis (PCA) and Single Value Decomposition (SVD).  
4. Design an expert system for simple application (speech recognition, speaker recognition, face recognition).  
5. Consider a real time data available in college campus and develop a data analytic system to determine the average, trend and prediction  

| Total Laboratory Hours |  30 hours  

Mode of Evaluation: Continuous Assessment and FAT  
Recommended by Board of Studies  |  26/04/2019  
Approved by Academic Council  |  No.55  
Date  |  13/06/2019  

M.TECH (MTS)  |  Page 27
Course code | Course title | L | T | P | J | C
--- | --- | --- | --- | --- | --- | ---
ECE5006 | FLEXIBLE AND WEARABLE SENSORS | 3 | 0 | 0 | 0 | 3

Prerequisite: ECE5001-Principles of Sensors

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.

Expected 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 film electronics
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 chemical parameters
6. Gain the competency in transferring the conducting and semiconducting fibers to smart textiles

Student Learning Outcomes (SLO): 1,5

Module:1 | Overview of flexible electronics technology | 5 hours
--- | --- | ---
History of flexible electronics - Materials for flexible electronics: degrees of flexibility, 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

<table>
<thead>
<tr>
<th>Module:5</th>
<th><strong>Wearable haptics</strong></th>
<th>6 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
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<thead>
<tr>
<th>Module:6</th>
<th><strong>Wearable Bio, Chemical and Inertial sensors</strong></th>
<th>6 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
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<tr>
<th>Module:7</th>
<th><strong>Knitted electronic textiles</strong></th>
<th>6 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
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<thead>
<tr>
<th>Module:8</th>
<th><strong>Contemporary issues:</strong></th>
<th>2 hours</th>
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</table>

| Total Lecture hours: | 45 hours |

<table>
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<th><strong>Text Book(s)</strong></th>
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<thead>
<tr>
<th><strong>Reference Books</strong></th>
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</thead>
</table>

| Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar |

| Recommended by Board of Studies | 21-08-2017 |
| Approved by Academic Council | No. 47 | 05-10-2017 |
Course code: ECE5008  
Course title: MICRO AND NANO FLUIDICS 
Prerequisite: Nil
Syllabus version: 1.0

Course Objectives:
1. Introduce and discuss the fundamental physics of micro and nano scale fluids and their hydrodynamics.
2. Comprehend techniques of miniaturization, methods and tools to create microfluidic architectures and discuss various existing microfluidic devices.
3. Discuss and identify the usage of microfluidics in various lab-on-chip and bioreactor applications.
4. Investigate and compare microfabrication techniques to design vasculature and 3D micro-channels.

Expected Course Outcome:
1. Identify and understand the fundamental physics of micro and nano scale fluids and their hydrodynamics. Comprehend the basics of miniaturization, methods and tools to create microfluidic architectures.
2. Recognise and interpret the working principle of various existing microfluidic devices.
3. Describe various microfluidic lab-on-chip applications.
4. Acquaint with various bioreactor based microchips.
5. Investigate and compare various microfabrication techniques to design vasculature and 3D micro channels with existing techniques.
6. Incorporate simulation and microfluidic device fabrication knowledge for developing various microfluidic devices.

Student Learning Outcomes (SLO): 1,5

Module:1  
Fundamentals for Microscale and Nanoscale Flow  5 hours
Fluids and nonfluids, properties of fluids, classification of fluids, Newtonian and Non Newtonian fluids, pressure driven flow, reynolds number, Electrokinetic phenomena, Electric double layer, debye length, coupling species transport and fluid mechanics, Micro channel Resistance, Shear stress, capillary flow, flow through porous media, Diffusion, surface tension, contact angle and Wetting.

Module:2  
Hydrodynamics  4 hours
Introduction to surface, surface charge, surface energy, Thermodynamics of surfaces, Fluids in Electrical fields, The Navier Stokes equation, Boundary and Initial conditions problems.

Module:3  
Fabrication methods and techniques  4 hours
Patterning, Photolithography, Micromachining, Micromolding, Soft lithography, PDMS properties, Fabrication of microfluidics channels.

Module:4  
Microfluidic Devices  3 hours
Droplet Microfluids, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers.

Module:5  
Microfluidics Lab on Chip  3 hours
Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment.

<table>
<thead>
<tr>
<th>Module:6</th>
<th>Bioreactors on Microchips</th>
<th>4 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction and Parallel reaction in micro reactors, chemical separation, liquid chromatography</td>
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</table>

<table>
<thead>
<tr>
<th>Module:7</th>
<th>3D Vascular Network for Engineered tissues</th>
<th>5 hours</th>
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</table>

<table>
<thead>
<tr>
<th>Module:8</th>
<th>Contemporary issues:</th>
<th>2 hours</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Text Book(s)</th>
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</table>

<table>
<thead>
<tr>
<th>Reference Books</th>
</tr>
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</table>

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment: Continuous Assessment and FAT

Recommended by Board of Studies | 21-08-2017 |
Approved by Academic Council | No. 47 | Date | 05-10-2017 |
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<td>ECE5066</td>
<td>Chemical and Environmental Sensor</td>
<td>2</td>
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**Pre-requisite:** ECE5060-Principles of Sensors and Signal Conditioning  
**Syllabus Version:** 1.0

### Course Objectives

1. To extend engineering principles to electrochemical sensor development with a clear understating of oxidation and reduction of an electrolytic cell.
2. To propound the conception of ion selective and enzyme stabilized electrodes for the detection of chemical and biomolecules.
3. To be expedient in applying specific interaction methods in the recognition of ion selective gases using metal oxide based sensors.
4. Ability to analyze the modes of vibration and develop the suitable mass and thermal sensitive 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 to be 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 most common diseases like metabolic disorders  
   Evaluate process design criteria for gas treatment and air quality analysis

### Student Learning Outcomes (SLO):

1, 5, 14

**Module: 1**  
**Electrochemistry**  
4 hours  

**Module: 2**  
**Transduction Principles**  
4 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, photometric sensors

**Module: 3**  
**Chemical Sensing Elements**  
4 hours  

**Module: 4**  
**Potentiometric and Amperometric Sensors**  
4 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**  
4 hours  
Fiber optic biosensor, Fluorophore and chromophore based biosensor, Bioluminescence and
chemiluminescence based biosensors, Non labeled and labeled immune sensors, Microbial Biosensors: electrochemical, photomicrobial, Microbial thermistor. Application of microbial biosensors in glucose, ammonia, acetic acid, alcohol, BOD, methane sensing

<table>
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<tr>
<th>Module:6</th>
<th>Sensors in exhaust gas treatment</th>
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<th>Module:7</th>
<th>Measurement techniques for air quality</th>
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<tr>
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<th>Contemporary Issues</th>
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|  |
|---|---|
| Total Lecture: | 30 hours |

Text Book(s)


Reference Book(s)


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

List of Challenging Experiments: (Indicative)

<p>| 1 | Develop a suitable electrochemical cell which can distinguish normal and contaminated water samples. Cyclic voltammetry technique can be used as the detection method. Develop the electronic circuitry and display to indicate the type of water. | 6 hours |
| 2 | Interdigitated Electrodes (IDT) are required for effective chemical sensing application. Using copper as the electrode material, develop IDT finger type electrodes using suitable deposition method. | 6 hours |
| 3 | After analysing the advantages and drawbacks of various methods used for depositing the oxide materials on planar rigid substrates, deposit zirconium oxide on the IDT electrodes fabricated on alumina substrate using the suitable deposition method. | 6 hours |
| 4 | Among the various types of conductometric sensors, identify a suitable | 6 hours |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>Develop a potentiostat circuit for a chemoresistive sensor which can be used for gas sensing application. The nominal resistance of the sensor will be 100 to 130 ohms and the expected change in resistance will +/-5%. Develop the electronic circuit which can convert the change in resistance into a voltage signal/current signal.</td>
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<td>Total Laboratory Hours</td>
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Mode of Evaluation: Continuous Assessment and FAT

Recommended by Board of Studies: 26-04-2019

Approved by Academic Council: No. 55, Date: 13-06-2019
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**Prerequisite**: ECE5061 - IoT Fundamentals and Architecture  
**Syllabus Version**: 1.00

**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

**Expected 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.

**Student Learning Outcomes (SLO):**  5,7,17

<table>
<thead>
<tr>
<th>Module 1</th>
<th>Cloud Computing basics and enabling technologies</th>
<th>5 hours</th>
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<table>
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<tr>
<th>Module 2</th>
<th>Cloud Virtualisation</th>
<th>5 hours</th>
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<tbody>
<tr>
<td></td>
<td>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).</td>
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<tr>
<td>Module 3</td>
<td>Cloud Application Development in Python</td>
<td>4 hours</td>
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<tr>
<th>Module 4</th>
<th>Federated Cloud Service Management and IoT</th>
<th>3 hours</th>
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<tbody>
<tr>
<td>Cloud Service management (federated) –Cloud Life Cycle-service and management-Cloud architectures -Self organizing cloud architectures</td>
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<table>
<thead>
<tr>
<th>Module 5</th>
<th>Fog computing</th>
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<table>
<thead>
<tr>
<th>Module 6</th>
<th>Fog and edge computing</th>
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<tbody>
<tr>
<td>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/ protocols),WAN vs Low bandwidth networks.</td>
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<thead>
<tr>
<th>Module 7</th>
<th>Overview of Edge Data Analytics tools</th>
<th>3 hours</th>
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<tbody>
<tr>
<td>Python advance libraries(Pandas, Scikit Learn), Tensor flow and Yolo</td>
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<thead>
<tr>
<th>Module 8</th>
<th>Contemporary Issues</th>
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<th>Total Lecture:</th>
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Text Books:


**Reference Books:**


**Lab Tasks (30 Hours)**

**Cloud Platforms:** Microsoft Azure/IBM Bluemix

**Language:** Python

1. Pushing documents
2. Pushing Images and Processing
3. Mini Weather Station
4. Image analytics at cloud
5. Python Scikit learn
6. Tensor flow
7. Live video

**Recommended by Board of Studies**

13-09-2019

**Approved by Academic Council**

No. 56  Date  24-09-2019
<table>
<thead>
<tr>
<th>Course code</th>
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<td>ECE5068</td>
<td>IoT Security and Trust</td>
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**Objectives:**
To impart the knowledge and technical skills in designing secured and trustable IoT systems.

**Expected 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.

**Student Learning Outcomes (SLO):**  5,6,14

**Module 1**  
Fundamentals of encryption for cyber security  
5 hours


**Module 2**  
IoT security framework  
5 hours


**Module 3**  
Elementary blocks of IoT Security & Models for Identity Management  
4 Hours


**Module 4**  
Identity Management and Trust  
4 Hours


**Module 5**  
Access Control in IoT and light weight cryptography  
3 Hours

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

**Module 6**  
Security and Digital Identity in Cloud Computing  
4 Hours

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

<table>
<thead>
<tr>
<th>Module 7</th>
<th>Cyber Crimes, Hackers and Forensics</th>
<th>3 Hours</th>
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<table>
<thead>
<tr>
<th>Module:8</th>
<th>Contemporary Issues</th>
<th>2 Hours</th>
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<td>Total Lecture: 30 Hours</td>
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**Text Books:**


**Reference Books:**


**Typical List of Projects (not limited to)**

- Light weight cryptography
- Hybrid block ciphers.
- Encryption using applets
- Digital signatures
- Review of Trust in IoT transactions.
- Crypt analysis
- Cloud security
- Trust management in clouds

**Recommended by Board of Studies**

13-09-2019

**Approved by Academic Council**

No. 56 Date 24-09-2019
<table>
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</table>

| Syllabus version | v. 1.00 |

**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.

**Expected Course Outcome:** Students will be able to
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

**Student Learning Outcomes (SLO):**
5. Having design thinking capability
7. Having computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning)
20. Having a good digital footprint

**Module:1** | Markup Language | 3 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

**Module:2** | Scripting Language | 4 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

**Module:3** | Android Programming Framework | 5 hours
---|---|---
Mobile app development: Android Development environment, Simple UI Layouts and layout properties, GUI objects, Event Driven Programming, opening and closing a Database

**Module:4** | Industrial Internet Application | 4 hours
---|---|---
IIoT Fundamentals and Components, Industrial Manufacturing, Monitoring, Control, Optimization and Autonomy, Introduction to Hadoop and big data analytics

**Module:5** | Applications in agriculture | 3 hours
---|---|---
Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides.

**Module:6** | Applications in IoT enabled Smart Cities | 4 hours
---|---|---
### Module: 7  Healthcare applications  5 hours

Architecture of IoT for Healthcare, Multiple views coalescence, SBC-ADL to construct the system architecture. Use Cases: Wearable devices for Remote monitoring of Physiological parameter, ECG, EEG, Diabetes and Blood Pressure.

### Module: 8  Contemporary issues:  2 hours

<table>
<thead>
<tr>
<th>Text Book(s)</th>
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### Total Lecture hours: 30 hours

<table>
<thead>
<tr>
<th>Reference Books</th>
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<tbody>
<tr>
<td>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.</td>
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### Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

### List of Challenging Experiments (Indicative)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Hours</th>
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<tbody>
<tr>
<td>1. Design and development of wireless video surveillance robot</td>
<td>15</td>
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<tr>
<td>2. Design and implementation of wearable glove to enable sign to speech conversation</td>
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<tr>
<td>3. IoT based home automation with security features</td>
<td></td>
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<tr>
<td>4. Smart farming: IoT based system for smart agriculture</td>
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<tr>
<td>5. IoT application to improvise industrial automation</td>
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<tr>
<td>6. Smart Energy meters to minimize power consumptions with a statistical approach</td>
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<tr>
<td>7. Bringing intelligence body area network – Smart Healthcare systems</td>
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### Mode of assessment: Mid CAT, FAT

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<td>No. 56</td>
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## Course Details

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<td>ECE6003</td>
<td>MICROSYSTEMS AND HYBRID TECHNOLOGY</td>
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### Prerequisite
- ECE5001 Principles of Sensors

### Syllabus version
- 1.1

### 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.

### Expected Course Outcome:
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.

### Student Learning Outcomes (SLO): 1.5

#### Module: 1
**Introduction to MEMS and Microsystems**
- 3 hours
  - MEMS and Microsystems, Miniaturization, Benefits of Microsystems, Typical MEMS and Microsystems products, Evolution of Microfabrication and Applications.

#### Module: 2
**Introduction to Sensors and Actuators**
- 3 hours

#### Module: 3
**Materials for Microsystems**
- 4 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**
- 4 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**
- 4 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**
- 4 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** | 2 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
---|---|---

<table>
<thead>
<tr>
<th><strong>Text Book(s)</strong></th>
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</table>

**Reference Books**


**Mode of Evaluation:** CAT / Assignment / Quiz / FAT / Project / Seminar

**List of Challenging Experiments (Indicative)**

1. **Design and Simulation of MEMS Capacitance based Accelerometer:**
   
   In this topic, you need to design a capacitive accelerometer that has a full-scale Measurement range of ± 10 g. The accelerometer may be designed using a closed loop or an open-loop. You need to have reasonable over range protection in your device.
   
   **Specification:**
   
   Measurement range: ± 10g  
   
   Output capacitance: at least tens of fF level
   
   **Device simulation results (must take into account parasitic capacitance of your design):**  
   
   (a) **Static analyses:**
   
   Gap vs. acceleration  
   
   Capacitance (or differential capacitance) vs. acceleration  
   
   (identify sensitivity [F/g])
   
   (b) **Dynamic analyses:**
   
   Your device’s response on vibration.

2. **Piezoresistive barometric pressure sensor:**

   15 hours
In this topic, you need to design a piezoresistive pressure sensor that has the measurement range of 0 - 1.1 bar. You need to have a reasonable over range protection in your device.

**Specification:**
Measurement range: 0 - 1.1 bar.

**Device simulation results:**
(i) Strain in the piezoresistor vs. pressure
(ii) Resistance vs. pressure
(iii) Voltage output vs. pressure for Wheatstone bridge circuit output.

**Circuit integration issues:**
Temperature compensation circuit design

<table>
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<th>Total Laboratory Hours</th>
<th>30 hours</th>
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<tr>
<td><strong>Mode of assessment:</strong></td>
<td>Continuous Assessment and FAT</td>
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<td>No. 47 Date 05-10-2017</td>
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<tr>
<td>ECE6004</td>
<td>RF AND MICROWAVE SENSORS</td>
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</table>

Prerequisite: ECE5001-Principles of Sensors  
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 and applications.
3. To introduce comprehensive knowledge of wearable antenna.
4. To explore and understand basics of RFID technology.

**Expected 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 applications based on the radar systems.
4. Apply the basic knowledge in the measurement of RF radiation.
5. Gain knowledge about the RFID technology.

**Student Learning Outcomes (SLO):**  1,6,17

**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.**  5 hours

**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
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.
### Module: 7  |  RFID Sensors  |  8 hours  
**Introduction,** Components of RFID systems, hardware and software components, RFID standards, RFID applications.

### Module: 8  |  Contemporary issues:  |  2 hours  

| **Total Lecture hours:** | 45 hours |

### Text Book(s)

### Reference Books

### Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

<p>| Recommended by Board of Studies | 28.01.2017 |
| Approved by Academic Council | No. 47 | Date | 05-10-2017 |</p>
<table>
<thead>
<tr>
<th>Course code</th>
<th>Course title</th>
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<th>P</th>
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</tr>
</thead>
<tbody>
<tr>
<td>ECE6007</td>
<td>BIOMEDICAL SENSORS</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

**Prerequisite:** ECE5001-Principles of Sensors  
**Syllabus version:** 1.1

**Course Objectives:**

1. Introduce the students to different types of electrodes used in bio potential recording
2. To facilitate the students in recognizing electrode configuration and issues related with the electrode relative motions.
3. To expose the students to perceive the need for bio amplifiers and their characteristics needed to be design for various bandwidth and frequency response.
4. Review the cardiac, respiratory and muscular physiological systems. Study the designs of several instruments used to acquire signals from living systems.
5. To proclaim the conception in detection of chemical and biomolecules.
6. Students will be expedient in applying specific radiology methods in diagnostics and analysis.
7. The students also understand the theory behind the sound and tissue interaction, and able to apply in therapeutic application.

**Expected Course Outcome:**

1. Realize the need for reusable electrodes and understands the method of implementation.
2. Will be familiar with electrode placements for various biopotential recording as per the voltage range.
3. Capable of understanding the design principles of bio-amplifiers and drawback related with noises.
4. Gain knowledge for implementing different types of physiological parameter measurement using appropriate sensors.
5. Able to discuss, develop and apply site specific chemical sensors design and imaging techniques for typical issues  
   a. To disseminate the design knowledge in analyzing in-vivo ailments

**Student Learning Outcomes (SLO):** 1,5,14

**Module:1 Biopotential Electrodes**  
3 hours


**Module:2 EEG, EMG & ECG**  
3 hours

Bio signal characteristics – frequency and amplitude ranges. ECG – Einthoven’s triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG–unipolar and bipolar mode. EEG- procedure, signal artefacts, signal analysis, evoked potential, EMG- procedure and signal analysis, Nerve conduction study

**Module:3 Bio Amplifiers**  
3 hours

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation -
isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.

<table>
<thead>
<tr>
<th>Module:4</th>
<th>Physical Sensors in Biomedicine</th>
<th>8 hours</th>
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<table>
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<tr>
<th>Module:5</th>
<th>Sensors for Chemical Quantities in Biomedicine</th>
<th>3 hours</th>
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</thead>
<tbody>
<tr>
<td>Blood gas and pH sensor, electrochemical sensor, transcutaneous, optical fiber sensor, mass spectrometer, optical oximetry, pulseoximetry, earoximetry.</td>
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<thead>
<tr>
<th>Module:6</th>
<th>Detectors in Radiology</th>
<th>4 hours</th>
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<tbody>
<tr>
<td>X ray imaging with sensors, detectors in nuclear radiology, magnetic field sensors for imaging, magnetic resonance imaging.</td>
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<thead>
<tr>
<th>Module:7</th>
<th>Sound in Medicine</th>
<th>4 hours</th>
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</thead>
<tbody>
<tr>
<td>Interaction of Ultrasound with matter; Cavitations, Reflection, Transmission- Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications</td>
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</table>

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<tr>
<th>Module:8</th>
<th>Contemporary issues:</th>
<th>2 hours</th>
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<tr>
<th>Total Lecture hours:</th>
<th>30 hours</th>
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Text Book(s)

Reference Books

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)
1. Pulse oximetry can be a useful aid in decision-making, everyone’s oxygen saturation fluctuates, due to changing activities and health condition. Design a circuit to determine oxygen range, and record each measurement in the activity log. A SpO2 of greater than 95% is generally considered to be normal. If SpO2 of 92% or less (at sea level) indicate the condition using an alarm. Use two led source and two detectors to measure the saturation of oxygen in the test subject. 6 hours
<table>
<thead>
<tr>
<th></th>
<th>The overall aim, of this experiment, is to build and test an ECG amplifier and study its noise interference problem. The signals should be displayed, stored and processed. Modify the instrumentation amplifier to implement DC offset cancellation and driven-right leg circuit to reduce common-mode voltage due to interference and safeguard the patient from high voltage. Also, include a low-pass filter that limits the bandwidth of the amplifier.</th>
<th>6 hours</th>
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<tbody>
<tr>
<td>3</td>
<td>Impedance plethysmography is a method of determining changing tissue volumes in the body, based on the measurement of electric impedance at the body surface. Determine the change in the conductivity due to the flow volume which in turn changes the distribution of the introduced current in the volume conductor. Measure and analyze the conductivity using a DAQ system.</td>
<td>6 hours</td>
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<tr>
<td>4</td>
<td>Strain gauge plethysmography were used prospectively to study the hemodynamic changes. Design a strain gauges based plethysmograph in which the strain gauges should be designed so that the active portion of the gauge is the same as the circumference of the limb or digit being measured. This allows the plethysmograph to relate resistance change to volume change. The size for limb strain gauges should be 1-3 cm less that the circumference of the limb so they will stretch slightly. Digits strain gauge should be 0.5 cm less than the circumference of the digit. Analyze the volume change using a DAQ system.</td>
<td>6 hours</td>
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<tr>
<td>5</td>
<td>Design a method to analysis liquid flow velocity using a non-contact measurement technique(Laser/Ultrasonic sensor). Record the dynamic flow velocity using LabView</td>
<td>6 hours</td>
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Mode of assessment: Continuous Assessment and FAT
Recommended by Board of Studies  28.01.2017
Approved by Academic Council  No. 47  Date  05-10-2017

Total Laboratory Hours  30 hours
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>ECE6087</td>
<td>Multi-disciplinary Product Development</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
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</table>

Prerequisite: Nil

| Syllabus Version | 1.0 |

**Course Objectives:**
1. To develop the students for integrative thinking on good engineering practices.
2. To emphasize the students from shifting their mindset from theoretical to practical multi-disciplinary skills through installing the know-how of actual practice in industry field.

**Expected Outcomes:**
The student will be able
1. To demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools
2. To value the voice of the customer in getting the feedback
3. To demonstrate an understanding of quality in a product or service through tools.
4. To improve the design of the product in accordance with the quality standards
5. To apply various strategies of designing experiments, methods to uphold the status of six sigma and improve the reliability of a product.
6. Strive towards efficient manufacturing process by systematic resource procurement
7. Analyze and demonstrate knowledge in product development

**Student Learning Outcomes (SLO):** 4, 9, 12, 20

**Module:1 Customer Value and Market Segmentation** 6 hours
The way to measure value by what a customer is willing to pay. It is used as critical input for product function requirement development. No product can satisfy all the customers. Market Segmentation shows the methodology to target a specific customer group for product positioning.

**Module:2 Voice of customer** 6 hours
Voice of customer: A disciplined approach to directly collecting feedback and input from customers. Used throughout the Engineering and Marketing process.

**Module:3 Quality Function deployment** 6 hours
Critical to Quality and Quality function Deployment: Specify and quantify customer needs. Flow down those customer needs in each step of product development.

**Module:4 Design of Six Sigma** 6 hours
Integrate statistics into quality continuous improvement operation model. Design for Six Sigma used throughout the product development process in order to improve the correction of the first design delivery.

**Module:5 Design Principles** 6 hours
Sample design Principles: As little design as possible to satisfy customer expectations and eliminating any unnecessary complexity helps maximize business benefit.
**Module: 6  |  Design of Manufacturing  |  6 hours**
Design of Manufacturing: Consider product manufacturability during design phase. Manufacture product efficiently increases the organization competitive power.

**Module: 7  |  Strategic sourcing and e-sourcing  |  7 hours**
Strategic Sourcing and Standardized Parts: Leverage the expertise of external source is one of the key strategies to success. Parts standardization improves the manufacturing flexibility and reduces the quality issue. e-sourcing: Leverage web-based applications to deliver savings and productivity gains while conducting the strategic sourcing.

**Module: 8  |  Contemporary Issues  |  2 hours**

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<td><strong>Text Books:</strong></td>
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</table>

**Total Lecture:** 30 hours

Mode of Evaluation: Continuous Assessment and FAT
Recommended by Board of Studies 26-04-2019
Approved by Academic Council No. 55 13-06-2019
<table>
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<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>ECE6088</td>
<td>DEEP LEARNING - AN APPROACH TO ARTIFICIAL INTELLIGENCE</td>
<td>3</td>
<td>0</td>
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</table>

**Prerequisite:** Nil

**Syllabus Version:** 1.0

**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 discussions on chosen topic
5. To impart adequate knowledge on deep learning frameworks and their applications to solving engineering problems

**Course Outcomes:**
1. Gain knowledge about basic concepts of machine learning algorithms and identify machine learning techniques suitable for the given problem.
4. Understand the foundations of neural networks, how to build neural networks and learn how to lead successful machine learning projects
5. Identify the deep feed forward, convolution and recurrent neural networks which are more appropriate for various types of learning tasks in various domains
6. Implement deep learning algorithm and solve real world problems

**Student Learning Outcomes (SLO):** 1, 5, 7

**Module:1**
**Foundations of Machine Learning-I**
5 hours
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
Clustering- distance based- K-means, density based, association rule mining, validation techniques-cross validations, feature selection and dimensionality reduction, principal component analysis-Eigen values, Eigen vectors, Orthogonality- challenges motivating deep learning

**Module:3**
**Neural Networks for Classification and Regression**
6 hours
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, heuristics for faster training and avoiding local minima.

**Module:4**
**Deep Feed Forward Neural Networks**
6 hours
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 gradient problem, new optimization methods (adagrad, adadelta, rmsprop, adam), regularization methods (dropout, batch normalization, dataset augmentation), early stopping.

<table>
<thead>
<tr>
<th>Module:5</th>
<th>Convolutional Neural Networks</th>
<th>7 hours</th>
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<tbody>
<tr>
<td>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</td>
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<tr>
<th>Module:6</th>
<th>Recurrent Neural Networks</th>
<th>6 hours</th>
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<tbody>
<tr>
<td>Sequence learning with neural nets, unrolling the recurrence, training RNN- Backpropagation through time (BPTT), vanishing gradient problem, Gated recurrent unit (GRU), Long short term memory (LSTM), Bidirectional LSTMs, bidirectional RNNs</td>
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<thead>
<tr>
<th>Module:7</th>
<th>Deep Learning Tools and Applications</th>
<th>8 hours</th>
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</thead>
<tbody>
<tr>
<td>Tools: TensorFlow, Keras, PyTorch, Caffe, Theano, MXNet. Applications: Object detection with RCNN - YOLO, SSD. Speech recognition with RNN.</td>
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<thead>
<tr>
<th>Module:8</th>
<th>Contemporary Issues</th>
<th>2 hours</th>
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**Text Book(s)**


**Reference Book(s)**


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

Recommended by Board of Studies 26-04-2019
Approved by Academic Council No. 55 Date: 13-06-2019
Course Code | Course Title | L | T | P | J | C
--- | --- | --- | --- | --- | --- | ---
ECE6089 | AUTOMOTIVE SENSORS AND IN-VEHICLE NETWORKING | 2 | 0 | 2 | 0 | 3

Pre-requisite: ECE5060- Principles of Sensors and Signal Conditioning

Syllabus version 1.00

**Course Objectives:**

1. Acquaint with the basic automotive parts and the need for sensor integration in different automotive systems.
2. Discuss the basics of various Power train sensors and associated systems for proper vehicle 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 automotive systems.

**Course Outcome**

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

**Student Learning Outcomes (SLO):** 2, 5, 14

**Module: 1**

Introduction to Automotive Engineering, Automotive Management systems 4 hours


**Module: 2**

Power train Sensors 4 hours

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 4 hours

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, 6 hours
**Sensors for automotive vehicle convenience and security systems**

Gas sensors (CO₂), 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 dynamics control, Accelerators and tilt sensors for sensing skidding and anti-collision, Anti-collision techniques using ultrasonic Doppler sensors.

<table>
<thead>
<tr>
<th>Module:5</th>
<th>Air Bag and Seat Belt Pre tensioner Systems</th>
<th>3 hours</th>
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<tbody>
<tr>
<td></td>
<td>Principal Sensor Functions, Distributed Front Air Bag sensing systems, Single-Point Sensing systems, Side-Impact Sensing, and Future Occupant Protection systems.</td>
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<tr>
<th>Module:6</th>
<th>Passenger Convenience Systems</th>
<th>3 hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Tire Pressure Control Systems, Electromechanical Window Drives, etc.</td>
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<tr>
<th>Module:7</th>
<th>Modern Trends and Technical Solutions</th>
<th>4 hours</th>
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<tr>
<td></td>
<td>Enabling Connectivity by Networking:-In vehicle communication standards (CAN &amp; 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.</td>
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<tr>
<th>Module:8</th>
<th>Contemporary Issues</th>
<th>2 hours</th>
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<tr>
<th>Total</th>
<th>30 hours</th>
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**Text Book(s)**


**Reference Books**


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

**List of Challenging Experiments: (Indicative)**

1. Tire Pressure Monitoring Systems uses a wireless radio frequency signal to communicate the tire pressure from sensors inside the wheel to a receiver centrally located in the vehicle. The sensors are powered by batteries that eventually wear out, so the amplitude of the transmitted signal decreases over time. 6 hours
signal is minimized in order to conserve power. Unfortunately, this has resulted in unreliable communication and it is not uncommon to lose communication with the sensors resulting in a false low-pressure indication. Develop a better way of sending RF signals from the wheels to the vehicle to conserve power and improve communication.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Hours</th>
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<tr>
<td>2</td>
<td>After studying the characteristics of various types of thermal sensors, develop a suitable system which can measure the automotive engine temperature in a non-contact method with an accuracy of +/-0.5°C.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Anti-collision system is preferred for all the automotive systems to improve the passenger safety. Using the Doppler effect as the detection principle, develop an anti-collision system using ultrasonic transceivers.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>In certain situations, airbag triggering in the automotive systems must be prevented when deployment would be injurious to one of the vehicle’s occupants (for instance, if a child is sitting in the seat next to the driver, or a child’s safety seat is fitted). Develop an intelligent occupant classification system which can classify based on distance between hip bones, occupied surface, profile structure and dynamic response.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Develop an intelligent inertial navigation system using motion sensors (accelerometers), rotation sensors (gyroscopes), and magnetic sensors (magnetometers), to continuously calculate the position, orientation, and velocity (direction and speed of movement) of an automotive system.</td>
<td>6</td>
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</tbody>
</table>

Total Laboratory Hours 30 hours

Mode of Evaluation: Continuous Assessment and FAT

Recommended by Board of Studies 26-04-2019

Approved by Academic Council No. 55 Date 13-06-2019
### Course Code | Course Title | L | T | P | J | C
---|---|---|---|---|---|---
ECE6090 | Fiber optic Sensors and Photonics | 3 | 0 | 0 | 0 | 3
Prerequisite | ECE5060 Principles of Sensors and Signal Conditioning | Syllabus Version | 1.0

### Course Objectives

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

### Course Outcomes

1. Attainment of basic knowledge of optical waveguides and optical devices employed in optical sensors.
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 given application.
4. Identify and apply the knowledge in designing interferometric devices which is more effectively used in sensing.
5. Will be aware of different polymers and their chemical, optical characteristics to formulate miniaturized optical devices.

### Student Learning Outcomes (SLO): 2, 6, 12

#### Module:1

**Theory of Optical Waveguides**


#### Module:2

**Active and Passive Optical Components**

Electro-optic and acousto optic wave guide devices, directional couplers, optical switch, phase and amplitude modulators, filters, etc., Y junction, power splitters, arrayed waveguide devices, fiber pigtailed, endfiber prism coupling, FBG and fabrication of FBG, Tapered couplers.

#### Module:3

**Intensity and Polarization Sensors**


#### Module:4

**Interferometric Sensors**


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M.TECH (MTS) Page 57
velocity sensors-Applications- Sagnac Interferometer for rotation sensing. Magnetic and electric field sensors: Intensity and phase modulation types – applications.

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 Sensors  |  5 hours
---|---|---
Fiber based Chemical Sensing : Absorption, Fluorescence, Chemi-luminescence, Vibrational Spectroscopic, SPR.

Module:7  |  Fiber based Bio-Sensors  |  3 hours
---|---|---
Fiber based Bio-molecules sensing: High Index, SPR, Hollow core fiber probes, Label Free bio-molecules.

Module:8  |  |  2 hours
---|---|---

Total Lecture hours: 45 hours

Text Book(s):

Reference Book(s)

Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course and FAT

Recommended by Board of Studies 26/04/2019
Approved by Academic Council No. 55 Date 13/06/2019