VIT®

Vellore Institute of Technology

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

SCHOOL OF ELECTRONICS ENGINEERING

M. Tech Internet of Things & Sensor Systems

(M.Tech MTS)

Curriculum

(*2022-2023 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

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

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

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

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

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

VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

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

MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

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

M. Tech Internet of Things & Sensor Systems

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

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

M. Tech Internet of Things & Sensor Systems

PROGRAMME OUTCOMES (POs)

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

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

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

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

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

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

PO_07: Having a clear understanding of professional and ethical responsibility

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

M. Tech Internet of Things & Sensor Systems

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

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

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

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

M. Tech Internet of Things & Sensor Systems

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
Discipline Core	24
Discipline Elective	12
Projects and Internship	26
Open Elective	03
Skill Enhancement	05
Discipline Core - Non Graded	01
Total credits	70

Master of Technology in Internet of Things and Sensor Systems

School of Electronics Engineering

Programme Credit Structure	**Credits**
Discipline Core Courses	24
Skill Enhancement Courses	05
Discipline Elective Courses	12
Open Elective Courses	03
Project/ Internship	26
Total Graded Credit Requirement	70

Discipline Core Courses **24**

		L	**T**	**P**	**C**
MITS501L	Principles of Sensors and Signal Conditioning	2	0	0	2
MITS501P	Principles of Sensors and Signal Conditioning Lab	0	0	2	1
MITS502L	IoT Fundamentals and Architecture	2	0	0	2
MITS502P	IoT Fundamentals and Architecture Lab	0	0	4	2
MITS503P	Data Acquisition Lab	0	0	4	2
MITS504P	System Dynamics and Control Systems Lab	0	0	4	2
MITS505L	Microcontrollers for IoT Prototyping	3	0	0	3
MITS505P	Microcontrollers for IoT Prototyping Lab	0	0	2	1
MITS506L	Wireless Sensor Networks and IoT	3	0	0	3
MITS507L	Signal Processing and Data Analytics	3	0	0	3
MITS508L	Deep Learning — An Approach to Artificial Intelligence	3	0	0	3

Skill Enhancement Courses **05**

MENG501P	Technical Report Writing	0	0	4	2
MSTS501P	Qualitative Skills Practice	0	0	3	1.5
MSTS502P	Quantitative Skills Practice	0	0	3	1.5

Discipline Elective Courses **12**

MITS601L	Flexible and Wearable Sensors	3	0	0	3
MITS602L	Micro and Nano Fluidics	3	0	0	3
MITS603L	Chemical and Environmental Sensor	3	0	0	3
MITS604L	Cloud and Fog Computing	3	0	0	3
MITS605L	IoT Security and Trust	3	0	0	3
MITS606L	IoT Applications and Web development	3	0	0	3
MITS607L	Micro Systems and Hybrid Technology	3	0	0	3
MITS608L	RF and Microwave Sensors	3	0	0	3
MITS609L	Biomedical sensors	3	0	0	3
MITS610L	Multi-disciplinary Product Development	3	0	0	3
MITS611L	Automotive Sensors and in-Vehicle Networking	3	0	0	3
MITS612L	Fibre optic Sensors and Photonics	3	0	0	3

Open Elective Courses **03**

Engineering Disciplines | Social Sciences

Project and Internship **26**

MITS696J	Study Oriented Project	02
MITS697J	Design Project	02
MITS698J	Internship I/ Dissertation I	10
MITS699J	Internship II/ Dissertation II	12

Course Code	Course Title	L	T	P	C
MITS501L	Principles of Sensors and SignalConditioning	2	0	0	2
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 mechanismsand provide in-depth understanding of the principle of measurement, and theory of instruments and sensors for measuring velocity and acceleration
3. To give a fundamental knowledge on the basic laws and phenomena on which operation ofsensor transformation of energy is based.
4. To impart a reasonable level of competence in the design, construction, and execution ofmechanical measurements strain, force, torque and pressure

Course Outcomes:

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

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, Photodiodes, Avalanche photodiodes, CCDs.

Module:3	Intensity Polarization and Interferometric Sensors	4 hours

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

Module:4	Strain, Force, Torque and Pressure sensors	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 Sensors	4 hours

Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magnetostrictive sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. 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: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**
Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. microflow sensor, coriolis mass flow and drag flow sensor. Temperature sensors- thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor. Acoustic sensors- microphones-resistive, capacitive, piezoelectric, fiber optic, solid state - electrect microphone.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture:	**30 hours**

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

Mode of Evaluation: CAT / Assignment / Quiz / FAT

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

Course Code	Course Title	L	T	P	C
MITS501P	Principles of Sensors and Signal Conditioning Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To provide in depth knowledge in physical principles applied in sensing, measurement 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 ofsensor transformation of energy is based.
4. To impart a reasonable level of competence in the design, construction, and execution ofmechanical measurements strain, force, torque and pressure

Course Outcomes:

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

LIST OF EXPERIMENTS	
1. Design of signal conditioning circuits for strain gauges- Strain, Force, pressure,and torque measurement i. Strain measurement with Bridge Circuit ii. Beam force sensor using Strain Gauge Bridge iii. Beam deflection sensing with Strain Gauge Bridge iv. Diaphragm pressure sensor using Strain Gauge Bridge v. Shear strain and angle of shift measurement of hollow shaft After completing the 1st set of characteristics. Design a weighing machine having arange of 0-5 Kg with a sensitivity of 5 mg. What modification he/she has to do tochange the upper range to 100 Kg with a sensitivity of 100 mg.	8 hours
2. Develop a displacement measurement system with the following sensors: i. Inductive transducer (LVDT) ii. Hall effect sensor	4hours
3. After studying the characteristics of temperature sensors listed below, develop a temperature measurement system for a particular application using the suitablesensor. 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	6hours

4. Develop a sensor system for force measurement using piezoelectric transducer			4hours
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.			8hours
		Total Laboratory hours	**30hours**
Mode of Evaluation: CAT/ FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MITS502L	IoT Fundamentals and Architecture	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

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

Course 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.

Module:1	Evolution of IoT	4 hours

Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting, IPV4 addressing and challenges). IPV6 addressing. IoT architecturereference layer.

Module:2	Introduction to IoT components	4 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	4 hours

MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP, COAP,XMPP and gateway protocols,

Module:4	IoT point to point communication technologies	4 hours

IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA, Lifi, Widi)

Module:5	Introduction to Cloud computation and Bigdata analytics	4 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	4 hours

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.	4 hours

Case studies: IoT for smart cities, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, “Enabling things to talk – Designing IoT solutions withthe IoT Architecture Reference Model”, Springer Open, 2016
2.	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, “From Machine to Machine to Internet of Things”, Elsevier Publications, 2014.
Reference Books	
1.	LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.
2.	Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally “Internet of Things A Hands-on-Approach” Arshdeep Bahga & Vijay Madisetti, 2014.
3.	Asoke K Talukder and Roopa R Yavagal, “Mobile Computing,” Tata McGraw Hill, 2010.
4	Barrie Sosinsky, “Cloud Computing Bible”, Wiley-India, 2010
5	RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to Secure Cloud Computing,Wiley-India, 2010
Mode of Evaluation: CAT / Assignment / Quiz / FAT	

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

Course Code	Course Title	L	T	P	C
MITS502P	IoT Fundamentals and Architecture Lab	0	0	4	2
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

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

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.

Lab Experiments	Hours
C programming	10
C++/JAVA programming	10
Python programming	10
Thinkspeak/thingsboard cloud platforms	10
Nodered	10
IoT usecases	10
Total Laboratory hours	**60 hours**
Mode of Evaluation: CAT/ FAT	

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

Course Code	Course Title	L	T	P	C
MITS503P	Data Acquisition Lab	0	0	4	2
Pre-requisite	NIL	Syllabus Version			
		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 synchronizedata acquisition tasks and analyze the data in MATLAB/ LabVIEW
4. To impart adequate knowledge on programming finite and continuous acquisitions, as well asbest practices in hardware/software timing, triggering, and logging.
5. To give hands-on experience configuring and programming NI data acquisition hardware usingNI-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/Osubsystems 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 produceaccurate 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

Lab Experiments

Task 1		**8 hours**
LabVIEW Graphical Programming, NI DAQmx, Data acquisition Toolbox to read data into MATLABand Simulink and write data into DAQ device.		
Task 2		**6 hours**
Acquire and generate analog signals.		
Task 3		**6 hours**
Acquire and generate non-clocked digital data.		
Task 4		**6 hours**
Measure frequency, pulse width and count pulses using NI devices		
Task 5		**6 hours**
Generate Pulse Width Modulated signal		
Task 6		**4 hours**
Acquire and generate audio signals		
Task 7		**6 hours**

Simultaneous and synchronized data acquisition		
Task 8		**4 hours**
Simulink data acquisition		
Task 9		**6 hours**
Arduino based multi-channel data acquisition		
Task 10		**8 hours**
Remote data acquisition with NI WSN Gateway and nodes, CC3200 (WiFi)		
	Total Laboratory hours	**60 hours**

Text Book(s)	
1.	BehzadAhzani “Data Acquisition using LabVIEW” Packt Publishing, 2017
2.	Data Acquisition Toolbox – User’s Guide, MathWorks, 2016
Reference Book(s)	
1.	Lab VIEW: A Developer's Guide to Real World Integration edited by Ian Fair weather,Anne Brumfield, 2011, CRC Press.
2.	DSP for Matlab and LabVIEW: Fundamentals of discrete signal processing, Morganand Claypool Publishers, 2009
3.	Maurizio Di Paolo Emilio, “Data Acquisition Systems- Fundamentals to AppliedDesign” , Springer, 2013.
4.	“Data Acquisition Handbook”, Measurement and computing corporation, 2012

Mode of evaluation: CAT/ FAT

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

Course Code	Course Title	L	T	P	C
MITS504P	System Dynamics and Control Systems Lab	0	0	4	2
Prerequisite:	NIL	Syllabus Version			
		1.0			

Course Objectives:

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

Course Outcome

1. Realize the need of control system and its recent developments. Able to model the system andsimulate the model.
2. Analyze the behavior of the first and second order systems in time domain and frequencydomain.
3. Analyze the system stability based on time domain, frequency domain and root locustechniques.
4. Identify the need for incorporating the three term controller based on the customizedrequirement of the control action
5. Analyze the systems behavior in digital domain and develop digital control algorithm for thecorrective action.

Text Book(s)

1.	Katsuhiko Ogata, “Modern Control Engineering”, 2010, 5th ed., Prentice Hall, New JerseyUSA.
2.	M. Gopal “Modern Control System Theory”, 2014, 2nd ed. New Age International, NewDelhi, India.

Reference Book(s)

1.	M. Gopal,"Digital control and state variable methods”, 2012, 4th ed., Tata McGraw Hill,USA.
2.	Webb & Reis, “Programmable Logic Controller - Principles and Applications”, 2012, 5thed., PHI, New Delhi, India.
3.	I. J. Nagrath and M. Gopal, "Control Systems Engineering", 2017, 6th Ed., New AgeInternational (p) Limited. New Delhi, India.

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 usingarmature control system	4 hours
4.	Modeling and performance analysis of stepper motor position controlsystem	4 hours
5.	Performance analysis of BLDC motor control system and its parameterestimation	4 hours
6.	ON/OFF temperature control system using LabVIEW platform	4 hours
7	Step response analysis of second order system using Matlab	4 hours

8	Frequency response analysis of LEAD/LAG compensating network	6 hours
9	Temperature control of a plant using PID controller with LabVIEWplatform/MSP430	6 hours
10	Modelling and implementation of level control system using PLC	6 hours
11	a) Modelling and implementation of 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 logiccontroller	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: CAT/FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MITS505L	Microcontrollers for IoT Prototyping	3	0	0	3
Prerequisite:	NIL	Syllabus Version			
		1.0			

Course Objectives: The course is aimed to

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

Course Outcomes:

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

Module:1	**MSP430 microcontrollers**	**7 hours**

Architecture of the MSP430, Memory, Addressing modes, Reflections on the CPU instruction set.Clock system, Exceptions: Interrupts and resets. Functions and subroutines, Mixing C and assembly language, Interrupts, Interrupt service routines, Issues associated with interrupts, Low-power modes of operation.

Module:2	**ARM Cortex MX microcontroller**	**6 hours**

ARM Cortex M4: Assembly language basics, Thumb-2 Technology, ARM Instruction set, Cortex M4 architecture, advantages, peripherals, instruction set, floating point operations, Advanced Cortex MX Microcontroller, core, architecture, on-chip wi-fi.

Module:3	**Display and Communication modules**	**6 hours**

GPIO, LCD display, graphical display, relays, Peripheral programming SPI, I2C, UART, Zigbee controller.

Module:4	**Sensors interfacing**	**6 hours**

Sensors interfacing techniques- Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11, single wire thermometer, Frequency counters.

Module:5	**Microcontrollers for IoT**	**6 hours**

ESP8266, NodeMCU, TI-CC3200, Access point and station point mode, HTTP, MQTT, transmission and receiving, Intel-Gallileo boards.

Module:6	**Single board computers**	**6 hours**

Raspberry pi board, porting Raspbian, sensor interface examples, Python programming for cloud access, sensor systems using Arduino boards

Module:7	**Cloud interfacing**	**6 hours**

Interfacing and data logging with cloud: Thing speak, Things board, Blync platform.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture:	**45 hours**

Text Book(s)

1. John H. Davies, “MSP430 Microcontroller Basics”, 2011, 2nd ed., Newnes publishing, NewYork.

2. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2014, 4th ed., Springer, New York.			
Reference Book(s)			
1. Sergey Y. Yurish,”Digital Sensors and Sensor Systems: Practical Design”, 2011, 1st ed., IFSApublishing, New York. 2. Jonathan W Valvano, “Introduction to ARM Cortex –M3 Microcontrollers”, 2012, 5th ed.,Create Space publishing, New York. 3. Muhammad Ali Mazidi, Shujen Chen, SarmadNaimi, SepehrNaimi, “TI ARM Peripherals Programming and Interfacing: Using C Language”, 2015, 2nd ed., Mazidi and Naimi publishing, New York.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT.			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MITS505P	Microcontrollers for IoT Prototyping Lab	0	0	2	1
Prerequisite	NIL	Syllabus Version			
		1.0			

Course Objectives: The course is aimed to

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

Course Outcomes:

1. Design and develop embedded programs for low power microcontrollers for sensorapplications.
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.

List of Experiments: (Indicative)	
1. Working with MSP430 (CCStudio) ● Sub Task 1: Port programming of MSP430 microcontrollers ● Sub Task 2: Analog to Digital Conversion using MSP430 microcontroller ● Sub Task 3: LCD display of characters and numbers. ● Sub Task 4: Timer	6 hours
2. Working with ARM (Keil and energia) ● Sub Task 1: Peripheral programming of ARM7 board ● Sub Task 2: PWM generation ● Sub Task 3:Configuring CC3200, wifi configuration ,HTTP and MQTTProtocol	8 hours
3. Low power wireless transmission using Zigbee ● Sub Task 1 : Interfacing Zigbee controller with MSP 430 microcontrollerusing SPI/UART. ● Sub Task 2: Programming sleep and wake up mode of MSP 430.	8 hours
4. IoT systems ● Working with Raspberry pi using Python. ● Arduino platform ● Working with open source clouds	8 hours
Total Laboratory Hours	**30 hours**

Mode of Evaluation: CAT/ FAT

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

Course Code	Course Title	L	T	P	C
MITS506L	Wireless Sensor Networks and IoT	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives

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

Course Outcomes

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

Module:1	Network for embedded systems	7 hours

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

Module:2	Embedded wireless communication andProtocols	6 hours

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

Module:3	Wireless sensor network (WSN)	6 hours

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

Module:4	WSN (Medium access control)	6 hours

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

Module:5	**Sensor Network Architecture**	**6 hours**
Data Dissemination, Flooding and Gossiping-Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs- Gateway Concepts, Need for gateway, WSNand Internet Communication, WSN Tunneling		
Module:6	**IP based WSN**	**6 hours**
Circuit switching, packet switching, concept of IPV4, IPV6, 6LOWPAN and IP, IP based WSN,6LOWPAN based WSN.		
Module:7	**Tiny OS**	**6 hours**
Tiny OS for WSN and IoT, M2M communication, Alljoyn network		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

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

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

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

Course Objectives:

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

Course Outcomes:

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

Module:1	Discrete Random Signal Processing	7 hours

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

Module:2	Signal Modeling	6 hours

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

Module:3	Feature extraction	6 hours

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

Module:4	Time series analysis	6 hours

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

Module:5	Reduction of dimensionality	6 hours

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

Module:6	Machine learning	6 hours

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

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

Text Book(s)

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

Reference Books

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

Mode of Evaluation: CAT / Assignment / Quiz / FAT

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

Course Code	Course Title	L	T	P	C
MITS508L	**Deep Learning - An Approach to Artificial Intelligence**	**3**	**0**	**0**	**3**
Prerequisite:	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives:

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

Course Outcomes:

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

Module:1	**Foundations of Machine Learning-I**	**5 hours**

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 andsoftmax. 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.

Module:5	**Convolutional Neural Networks**	**7 hours**

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

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

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

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

Course Objectives:

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

Course Outcome:

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

Module:1	Overview of flexible electronics technology	5 hours

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

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

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

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

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

Module:4	Flexible electronics from foils to textiles	6 hours

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

Module:5	Wearable haptics	6 hours

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

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

Introduction-Systems design - Challenges in chemical and biochemical sensing - Application areas -Wearable inertial sensors - obtained parameters from inertial sensors - Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Application in clinical practice and future scope		
Module:7	**Knitted electronic textiles**	**6 hours**
From fibers to textile sensors - Interlaced network -Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors and other applications. FBG sensor in Intelligent Clothing and Biomechanics.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, "Sensor Technologies: Healthcare, Wellness and Environmental Applications", 201, 1st Edition , Apress Media LLC, New York.

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

Reference Books

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

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

3. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1stEdition, World Scientific Publishing Co, Singapore.

4. Yugang Sun, John A. Rogers, "Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies)', 2011, 1st Edition, William Andrew, New York.

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

Course Code	Course Title	L	T	P	C
MITS602L	Micro and Nano Fluidics	3	0	0	3
Prerequisite:	NIL	Syllabus version			
		1.0			

Course Objectives:

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

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 3Dmicro channels with existing techniques.
6. Incorporate simulation and microfluidic device fabrication knowledge for developingvarious microfluidic devices.

Module:1	Fundamentals for Microscale and NanoscaleFlow	7 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	6 hours

Introduction to surface, surface charge, surface energy, Thermodynamics of surfaces, Fluids in Electrical fields, The Navier Strokes equation, Boundary and Initial conditions problems

Module:3	Fabrication methods and techniques	6 hours

Patterning, Photolithography, Micromachining, Micromolding, Soft lithography, PDMSproperties, Fabrication of microfludics channels.

Module:4	Microfluidic Devices	6 hours

Droplet Microfluids, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers

Module:5	Microfluidics Lab on Chip	6 hours

Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment.

Module:6	Bioreactors on Microchips	6 hours

Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction andParallel reaction in micro reactors, chemical separation, liquid chromatography

Module:7	3D Vascular Network for Engineered tissues	6 hours

Fabrication, Microfabrication of vasculature, Materials for 3D Microfluidic vasculature, Laser Micro-machined 3D channels, Introduction to Comsol Multiphysics, Mathematical Modeling ofMicrochannels in Microfludics Model builder.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Clement Kleinstreuer, "Microfluidics and Nanofluidics: Theory and Selected Applications", 2013, 1st ed., John Wiley & Sons, New Jersey.	
2.	Shaurya Prakash, JunghoonYeom, "Nanofluidics and Microfluidics: Systems	
Reference Books		
1.	Albert Folch, "Introduction to BioMEMS", 2012, 1st ed., CRC Press, United Kingdom.	
2	Patrick Tabeling, "Introduction to Microfluidics", 2011, Reprint ed., Oxford University Press, Great Britain.	
3	Xiujun James Li, Yu Zhou , "Microfluidic Devices for Biomedical Applications", 2013, 1sted., Wood head Publishing, Cambridge.	
4	Terrence Conlisk. A, "Essentials of Micro- and Nanofluidics: With Applications to theBiological and Chemical Sciences", 2012, 1st ed., Cambridge University Press, New York.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT		
Recommended by Board of Studies	28-07-2022	
Approved by Academic Council	No. 67	Date 08-08-2022

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

Course Objectives

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

Course Outcomes

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

Module:1	Electrochemistry	7 hours

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

Module:2	Transduction Principles	6 hours

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

Module:3	Chemical Sensing Elements	6 hours

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

Module:4	Potentiometric and Amperometric Sensors	6 hours

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

Module:5	Optical Biosensor and Immunosensors Biosensor	6 hours

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

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

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

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

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

Course Objectives:

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

Course Outcome:

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

Module 1	Cloud Computing basics and enablingtechnologies	7 hours

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

Module 2	Cloud Virtualisation	6 hours

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

Module 3	Cloud Application Development in Python	6 hours

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

Module 4	Federated Cloud Service Management andIoT	6 hours

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

Module 5	Fog computing	6 hours

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

Module 6	Fog and edge computing	6 hours

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

Module 7	Overview of Edge Data Analytics tools	6 hours

Python advance libraries(Pandas, Scikit Learn), Tensor flow and Yolo

Module 8	Contemporary Issues	2 hours

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

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

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

Objectives:

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

Outcome:

At the end of the course students will be able to

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Course Code	Course Title	L	T	P	C
MITS606L	IoT Applications and Web development	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

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

Course 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

Module:1	Markup Language	7 hours

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

Module:2	Scripting Language	6 hours

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

Module:3	Android Programing Framework	6 hours

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

Module:4	Industrial Internet Application	6 hours

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

Module:5	Applications in agriculture	6 hours

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

Module:6	Applications in IoT enabled SmartCities	6 hours

Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid andSolar Energy Harvesting, Intelligent Parking, Data lake services scenarios.

Module:7	Healthcare applications	6 hours

Architecture of IoT for Healthcare, Multiple views coalescence, SBC-ADL to construct the system architecture. Use Cases: Wearable devices for Remote monitoring of Physiological parameter, ECG, EEG, Diabetes and Blood Pressure.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	John Dean, Web Programming with HTML5, CSS and JavaScript, 2018, Jones andBartlett Publishers Inc., ISBN-10: 9781284091793
2.	DiMarzio J. F., Beginning Android Programming with Android Studio, 2016, 4th ed.,Wiley, ISBN-10: 9788126565580
Reference Books	
1.	Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRC Press,ISBN-10: 1138316849
2.	Giacomo Veneri, and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, 2018, Packt Publishing.
3.	Subhas Chandra Mukhopadhyay, Smart Sensing Technology for Agriculture and Environmental Monitoring, 2012, Springer, ISBN-10: 3642276377

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

Course Code	Course Title	L	T	P	C
MITS607L	Microsystems and Hybrid Technology	3	0	0	3
Prerequisite	NIL	Syllabus version			
		1.0			

Course Objectives:

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

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 applicationsof various MEMS devices micromachining tools and techniques
6. Acquainted with thick film and hybrid technologies for sensor development.
7. Incorporate simulation and micro-fabrication knowledge for developing various MEMS devices.

Module:1	Introduction to MEMS and Microsystems	7 hours

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

Module:2	Introduction to Sensors and Actuators	6 hours

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

Module:3	Materials for Microsystems	6 hours

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

Module:4	Scaling Effects in Microsystems	6 hours

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

Module:5	Micromachining Technologies	6 hours

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

Module:6	MEMS and micro systems applications	6 hours

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

Module:7	**Hybrid Technology**	**6 hours**
Thick-film and hybrid technology in sensor production. Basic materials, components, manufacturing Screen manufacturing, Screen printing, Parameters, Comparison: thick- vs. thin- film technology Structure dimensions, Assembly and packaging Surface mount technology (SMT) Active and passive devices (SMD), Connection technologies, Packaging.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	G.K.Ananthasuresh, K J Vinoy, S Gopalakrishnan, KN Bhatt, V K Aatre," Micro and smartsystems", 2012, 1st ed., Wiley, New York.
2.	Tai-Ran Hsu, "MEMS & Microsystem, Design and Manufacture", 2017, 1st ed., McGraw HillIndia, New Delhi.
Reference Books	
1.	Mahalick NP, "MEMS", 2017, 1st ed., Tata McGraw Hill, New Delhi
2	Wolfgang Menz, Jürgen Mohr, Oliver Paul, "Microsystem Technology", 2011, 2nd ed., Wiley,New York.
3	Banks H.T. Smith R.C. and Wang Y.Smart, 'Material Structures – Modeling, Estimation andControl', 2011, 1st ed., John Wiley & Sons, NewYork.
4	Massood Tabib – Arar, 'Microactuators – Electrical, Magnetic Thermal, Optical, Mechanical, Chemical and Smart structures', 2014, 1st ed., Kluwer Academic publishers, New York .

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

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

Course Objectives:

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

Course Outcome:

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

Module:1	RF Sensors	6 hours

Microwave Antenna-Introduction, types of Antenna, fundamental parameters of antennas, radiation mechanism, Fresnel and Fraunhofer regions. Antenna for communication and Antenna for sensing, radiometer and radar

Module:2	Antenna for personal area communication.	6 hours

Concepts of Printed Antennas, Broadband Microstrip Patch Antennas, Antennas for Wearable Devices, Design Requirements, Modeling and Characterization of Wearable Antennas, WBAN Radio Channel Characterization and Effect of Wearable Antennas, Domains of Operation, Sources on the Human Body, Compact Wearable Antenna for different applications.

Module:3	Radar	5 hours

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

Module:4	Applications of Radar	6 hours

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

Module:5	Radiometers	6 hours

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

Module:6	Microwave power Sensors	6 hours

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

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

Course Code	Course Title	L	T	P	C
MITS609L	Biomedical Sensors	3	0	0	3
Prerequisite:	NIL	Syllabus version			
		1.0			

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 theelectrode relative motions.
3. To expose the students to perceive the need for bio amplifiers and their characteristicsneeded to be design for various bandwidth and frequency response.
4. Review the cardiac, respiratory and muscular physiological systems. Study the designs ofseveral 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 andanalysis.
7. The students also understand the theory behind the sound and tissue interaction, and able toapply in therapeutic application.

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 thevoltage range.
3. Capable of understanding the design principles of bio-amplifiers and drawback relatedwith noises.
4. Gain knowledge for implementing different types of physiological parameter measurementusing appropriate sensors.
5. Able to discuss, develop and apply site specific chemical sensors design and imagingtechniques for typical issues
6. To disseminate the design knowledge in analyzing in-vivo ailments

Module:1	Biopotential Electrodes	7 hours

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits.Recording problems - measurement with two electrodes.

Module:2	EEG, EMG & ECG	6 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	6 hours

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

Module:4	**Physical Sensors in Biomedicine**	**6 hours**
Temperature measurement: core temperature,-surface temperature- invasive. Blood flow measurement: skin blood- hot film anemometer- Doppler sonography- electromagnetic sensor - blood pressure measurement: noninvasive- hemodynamic invasive. Spirometry- sensors for pressure pulses and movement- ocular pressure sensor- acoustic sensors in hearing aid, in blood flow measurement, sensors for bio-magnetism, tactile sensors for artificial limbs, sensors in ophthalmoscopy, artificial retina.		
Module:5	**Sensors for Chemical Quantities inBiomedicine**	**6 hours**
Blood gas and pH sensor, electrochemical sensor, transcutaneous, optical fiber sensor, massspectrometer, optical oximetry, pulseoximetry, earoximetry.		
Module:6	**Detectors in Radiology**	**6 hours**
X ray imaging with sensors, detectors in nuclear radiology, magnetic field sensors for imaging,magnetic resonance imaging.		
Module:7	**Sound in Medicine**	**6 hours**
Interaction of Ultrasound with matter; Cavitations, Reflection, Transmission- Scanning systems –Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications		
Module:8	**Contemporary Issues**	**6 hours**
Total Lecture hours:		**45 hours**

Text Book(s)	
1.	J. G. Webster, J. G. Webster ,"Medical Instrumentation; Application and Design", John Wiley& Sons, Inc., New York, 4th Edition, 2015
Reference Books	
1.	Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi,3rd edition ,2014.
2	John Enderle, Joseph Bronzino, "Introduction to Biomedical Engineering", Academic Press,3rd Edition, 2011.
3	Myer Kutz, "Biomedical Engineering and Design Handbook, Volume 1: Volume I: Biomedical Engineering Fundamentals", McGraw Hill Publisher, USA, 2nd Edition 2009.

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

Course Code	Course Title	L	T	P	C
MITS610L	Multi-disciplinary Product Development	3	0	0	3
Prerequisite:	NIL	Syllabus Version			
		1.0			

Course Objectives:

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

Course Outcomes:

The student will be able

1. To demonstrate an understanding of the overview of all the product development processesand 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 sixsigma 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

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 fromcustomers. 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 firstdesign 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**
	Total Lecture:	**45 hours**

Text Books:

1.	Tempelman, Shercliff, Van Eyben, "Manufacturing and Design, Elsevier, 1st edition, 2014
2.	Art Weinstein, "Handbook of Market Segmentation: Strategic Targeting for Business and Technology Firms, Third Edition (Haworth Series in Segmented, Targeted, and CustomizedMarket), 3rd ed. Routledge, Taylor and Francis group, 2004.
3.	Michael Lamoureux, "The e-Sourcing Handbook: A Modern Guide to Supply and Spend Management Success, Lasta publishing, 2008

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

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

Course Objectives:

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

Course Outcome

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

Module:1	Introduction to Automotive Engineering,Automotive Management systems	7 hours

Power-train, Combustion Engines, Transmission, Differential Gear, Braking Systems, Introduction to Modern Automotive Systems and need for electronics in Automobiles, Application areas of electronics in the automobiles, Possibilities and challenges in the automotiveindustry, Enabling technologies and Industry trends.

Module:2	Power train Sensors	6 hours

λ sensors, exhaust temperature sensor, NOx sensor, PM sensor, fuel quality sensor, level sensor,torque sensor, speed sensor, mass flow sensor, manifold pressure sensor.

Module:3	Sensors for Chassis management	6 hours

Wheel speed sensors/direction sensors, steering position sensor (multi turn), acceleration sensor(inertia measurement), brake pneumatic pressure sensor, ABS sensor, electronic stability sensor.

Module:4	Sensors for vehicle body management, Sensors for automotive vehicle convenienceand security systems	6 hours

Gas sensors (CO_2), Temperature/humidity sensor, air bag sensor, key less entering sensor, radar sensors. Tire pressure monitoring systems, Two wheeler and Four wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies, Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle

dynamics control, Accelerators and tilt sensors for sensing skidding and anti-collision, Anti-collision techniques using ultrasonic Doppler sensors.		
Module:5	**Air Bag and Seat Belt Pre tensioner Systems**	**6 hours**
Principal Sensor Functions, Distributed Front Air Bag sensing systems, Single-Point Sensingsystems, Side-Impact Sensing, and Future Occupant Protection systems.		
Module:6	**Passenger Convenience Systems**	**6 hours**
Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Tire Pressure Control Systems, Electromechanical Window Drives, etc.		
Module:7	**Modern Trends and Technical Solutions**	**6 hours**
Enabling Connectivity by Networking:-In vehicle communication standards (CAN & LIN), Telematic solutions, Portable or embedded connectivity- Endorsing Dependability in Drive-by- wire systems:- Terminology and concepts , Why by-wire, FLEXRAY, Requirements on cost and dependability, Drive-by-wire case studies- prototype development-future of In vehicle communication.		
Module:8	**Contemporary Issues**	**2 hours**
	Total	**45 hours**

Text Book(s)	
1.	Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5th Edition,BOSCH.
2.	John Turner, Automotive Sensors, 2010, 1st Edition, Momentum Press, New York.
Reference Books	
1	Automotive Sensors Handbook, 8th Edition, 2011, BOSCH.
2.	Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, IwaoYokomori, Sensors for AutomotiveTechnology, 2010, 4th Edition, Wiley, New York.
3.	Ernest O. Doebelin, “Measurement Systems – Application and Design”, 2017, 6th Edition,McGraw-Hill, New Delhi.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	28-07-2022		
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Course Code	Course Title	L	T	P	C
MITS612L	Fiber Optic Sensors and Photonics	3	0	0	3
Prerequisite	NIL	Syllabus Version			
		1.0			

Course Objectives

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

Course Outcomes

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

Module:1	Theory of Optical Waveguides	7 hours

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

Module:2	Active and Passive Optical Components	7 hours

Electro-optic and acousto optic wave guide devices, directional couplers, optical switch, phase and amplitude modulators, filters etc. Yjunction, powersplitters, arrayed wave guide devices, fiber pigtaling, end-fiber prism coupling, FBG and fabrication of FBG, Tapered couplers.

Module:3	Intensity and Polarization Sensors	7 hours

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

Module:4	Interferometric Sensors	7 hours

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

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

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

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	28-07-2022		
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Course Code	Course Title	L	T	P	C
MITS696J	Study Oriented Project				02
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcome:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content	(Project duration: One semester)

This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	28-07-2022		
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Course Code	Course Title	L	T	P	C
MITS697J	Design Project				02
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. Students will be able to design a prototype or process or experiments.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcome:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model or process or experiments.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content **(Project duration: One semester)**

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	28-07-2022		
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Course Code	Course Title	L	T	P	C
MITS698J	Internship I/ Dissertation I				10
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

Course Outcome:

1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work.
2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
3. A consciousness of the ethical aspects of research and development work.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Module Content **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

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

Course Code	Course Title	L	T	P	C
MITS699J	Internship II/ Dissertation II				12
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

Upon successful completion of this course students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

Module Content **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
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