CURRICULUM AND DETAILED SYLLABI

FOR

M. TECH DEGREE PROGRAMME

IN

IoT and Sensor Systems

2026 SCHEME
(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
MAR IVANIOS VIDYANAGAR, NALANCHIRA, THIRUVANANTHAPURAM – 695015, KERALA.
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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CURRICULUM and SYLLABI

Items	Board of Studies (BoS)	Academic Council (AC)
Date of Approval	27-02-2026	12-03-2026



Head of Department
Chairman, Board of Studies



Principal
Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committedprofessionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Electronics and Communication Engineering Education and Research for the service of humanity.

Mission:

To provide quality Engineering Education and to carry out Research in the field of Electronics and Communication Engineering addressing the challenges faced by the society.

CURRICULUM

Semester I (M1)

Slot	Course Type	Course Code	Course	Marks		Hours L - T - P	Credits
				CIA	ESE		
A	PCC	26EC161A	Random Process and Applications	50	50	4 – 0 - 0	4
B	PCC	26EC161B	IoT Fundamentals and Architecture	50	50	4 – 0 - 0	4
C	PCCP	26EC161C	Principles of Sensors and Signal Conditioning	50	50	3 – 0 - 2	4
D	PEC/PECP		Program Elective Course1/ Program Elective Course with practical component 1	50	50	3 – 0 – 0/ 2 – 1 – 0/ 2 – 0 - 2	3
E	PEC/PECP		Program Elective Course2/ Program Elective Course with practical component 2	50	50	3 – 0 – 0/ 2 – 1 – 0/ 2 – 0 - 2	3
S	AC	26AC061A	Research Methodology & IPR	50	50	2 – 0 - 0	0
T	LBC	26EC169A	IoT Data Acquisition and Analysis Lab	100	-	0 – 0 - 3	2
Total				**400**	**300**	**23-28**	**20**

Teaching Assistance: 6 hours

Program Elective Courses and Program Elective Course with practical component in M1 and M2 must be chosen from a single basket of all PECs and PECPs.

Semester II (M2)

Slot	Course Type	Course Code	Course	Marks		Hours L - T - P	Credits
				CIA	ESE		
A	PCCP	26EC161D	Microcontrollers for IoT	50	50	3 – 0 - 2	4
B	PEC/PECP		Program Elective Course 3/ Program Elective Course with practical component 3	50	50	3 – 0 – 0/ 2 – 1 – 0/ 2 – 0 - 2	3
C	PEC/PECP		Program Elective Course 4/ Program Elective Course with practical component 4	50	50	3 – 0 – 0/ 2 – 1 – 0/ 2 – 0 - 2	3
D	IEC/ SAEC*		Industry Elective / Skill/Ability Enhancement Course	50/-	50/-	3/2-0-0/2	3
S	PR	26EC167A	Mini project	100	-	0 – 0 - 6	3
T	LBC	26EC169B	IoT and Sensor Systems Lab	100	-	0 – 0 - 3	2
Total				**400**	**200**	**22-26**	**18**

Teaching Assistance: 6 hours

***Marks / GPA earned in this SAEC will be used for awarding GPA for this course.**

Semester III (M3)

Slot	Course Type	Course Code	Course	Marks		Hours L - T - P	Credits
				CIA	ESE		
A	SAEC**		Skill/ Ability Enhancement Course	To be successfully completed		-	3
D	PR	26EC178A	Project (Phase I)/ Project/ Internship	100 100 100	- 100 -	0-0-24 0-0-24 Industry norms	16
Total				**100**	**-/100/-**	**24**	**19**

Teaching Assistance for students doing Project (Phase I)/ Project in the college: 5 hours
**** This SAEC can be carried out at any time from M1 to M3, and credited in M3.**

Semester IV (M4)

Slot	Course Type	Course Code	Course	Marks		Hours L - T - P	Credits
				CIA	ESE		
D	PR	26EC178B	Project (Phase II)/ Project/ Internship	100 100 100	100 100 -	0 – 0 – 24 0 – 0 – 24 Industry norms	16
Total				**100**	**100/100/ -**	**24/ industry norms**	**16**

Teaching Assistance: 5 hours
Out of the 100 marks for internal assessment, 15 marks is reserved for publication. The project work shall be accepted for publication or published in a journal/ Conference before the final evaluation.

List of Program Elective Courses

Category Code	Course Number	Course Name	L	T	P	Credit
PEC	26EC162A	Flexible and Wearable Sensors	3	0	0	3
	26EC162B	Micro and Nano Fluidics	3	0	0	3
	26EC162C	Machine Learning	2	0	2	3
	26EC162D	Automotive Sensors and in-Vehicle Networking	3	0	0	3
	26EC162E	Cloud and Fog Computing	3	0	0	3
	26EC162F	IoT Security and Trust	3	0	0	3
	26EC162G	Biomedical sensors	3	0	0	3
	26EC162H	RF MEMS	3	0	0	3
	26EC162I	Wireless Sensor Networks and IoT	3	0	0	3
	26EC162J	IoT Applications and Web development	3	0	0	3
	26EC162K	Chemical and Environmental Sensor	3	0	0	3
	26EC162L	Nano Sensors	3	0	0	3
	26EC162M	Deep Learning	2	0	2	3
	26EC162N	Embedded Systems Design	3	0	0	3
	26EC1620	RF and Microwave Sensors	3	0	0	3
	26EC162P	Micro Systems and Hybrid Technology	3	0	0	3
	26EC262Q	Digital VLSI Design	2	0	2	3
	26EC162R	Fiber optic Sensors	3	0	0	3
	26EC162S	Large Scale Data Analytics	3	0	0	3

INDUSTRY ELECTIVE COURSES

Category Code	Course Number	Course Name	L	T	P	Credit
IEC	26EC166A	Automotive Electronics	3	0	0	3

SYLLABUS

SEMESTER I

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC161A	Random Process and Applications	PCC	4	0	0	4	2026

1) Course Objectives

The goal of this course is to familiarize the student with the theory and applications of probability theory, and thereby aid in understanding phenomena which evolve with respect to time in a probabilistic manner.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO1	Apply the fundamental knowledge of basic probability concepts.	Apply
CO2	Apply the concept of random variables and vectors.	Apply
CO3	Apply the concept of moments, characteristic function, convergence and inequalities.	Apply
CO4	Apply the basic concept of random process.	Apply
CO5	Apply the concept of special random process and noise.	Apply

3) Syllabus

Probability theory, Random variables, Probability Density function, Conditional and Joint Distributions and densities, Functions of Random Variables, Expectation, Conditional Expectation.

Moments, Random Vector, Random Processes, WSS Processes, Power spectral density, Inequalities, Central limit theorem.

Random Sequences, Ergodicity, Representation of Band limited and periodic Processes

4) References

1. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education, 3/e, 2002.
2. Athanasios Papoulis and S. Unnikrishnan Pillai, Probability, Random Variables and Stochastic Processes, TMH, 4/e, 2002.
3. Oliver C. Ibe., Fundamentals of Applied Probability and Random Process, Elsevier, 2005.
4. Gray, R. M. and Davisson L. D., An Introduction to Statistical Signal Processing, Cambridge University Press, 2004.
5. Gardner, W. A., Introduction to Random Processes with applications to Signals and Systems, 2nd edition, McGraw-Hill, Inc., 1990

5) Course Plan

Module	Contents	Hours
I	Fundamentals of Probability: Random experiments and sample space. Events: simple and compound events, set operations on events, Types of events: mutually exclusive, exhaustive events. Axioms of probability Probability Space: definition, Discrete and continuous probability spaces. Joint Probability: Joint probability mass function (PMF), Joint probability density function (PDF), Marginal probability distributions .Conditional Probability: Conditional probability mass	12

	and density functions, Relationship between joint and conditional probabilities.Bayes' Theorem: Statement and derivation of Bayes' Theorem, Applications of Bayes' Theorem Independent Events: Definition, Pairwise and mutual independence, Relationship between independence and conditional probability.Probabilistic Modeling of Sensor data, noise Discrete and Mixed random variables.	
II	Expectation: Fundamental Theorem of expectation, Conditional Expectation. Random Variables: Definition of random variables, Classification of random variables: discrete and continuous, Probability mass function (PMF), Probability density function (PDF), Cumulative distribution function (CDF) and its properties Random Vectors: Definition of random vectors, Joint distribution of random variables, Joint PMF and joint PDF, Marginal distributions. Distributions and Densities: Relationship between distribution functions and density functions, Properties of PMF and PDF. Independent Random Variables: Definition Conditions for independence using joint and marginal distributions, Properties of independent random variables. Functions of Random Variable: basic concept of one random variable and two random variables. Common distributions used in IoT: Bernoulli, Binomial, Poisson, Gaussian. Transformation of random variables, Distribution of a function of a single random variable, Method of distribution function, Change of variables technique Functions of Two Random Variables: Distribution of a function of two random variables, Joint transformation of random variables. Sensor Data Modeling Using Random Variables, Noise and Interference Modeling in IoT Sensors.	12
III	Moments of Random Variables: Definition of moments, Raw moments and central moments, Relationship between raw and central moments, Mean, variance. Characteristic Functions: Definition of characteristic function, Properties of characteristic functions, Relationship between moments and characteristic functions, Characteristic functions of standard random variables. Inequalities: Chebyshev's inequality, Schwartz (Cauchy–Schwarz) inequality. Convergence of Random Variables: Concept of convergence of random variables, Types of convergence: Almost sure convergence, Convergence in probability, Mean square convergence, Convergence in distribution. Statistical Characterization of Sensor Data and noise using Moments.	12
IV	Markov Chains, Chapman-Kolgomorov equations Random Processes: Definition of random process, Classification of random processes, Ensemble and sample functions. Stationarity and Ergodicity: Concept of stationarity, Ergodic processes,	12

	Relationship between stationarity and ergodicity. Stationary Random Processes: Strict Sense Stationary (SSS) processes, Wide Sense Stationary (WSS) processes, Comparison between SSS and WSS processes. Random Process through LTI System Markov models for event-based IoT: Birth-Death Markov Chains, Markov Chains. Covariance Functions: Autocorrelation and autocovariance functions, Cross-covariance function, Properties of covariance functions. Spectral Representation: Power spectral density (PSD), Relationship between time-domain and frequency-domain representations. Wiener–Khinchine Theorem: Statement and significance of Wiener–Khinchine theorem, Relationship between autocorrelation function and power spectral Density. Application of Random Process Modelling in IoT.	
V	Gaussian Processes: Definition of Gaussian random process, Properties of Gaussian processes, Mean and autocorrelation functions of Gaussian processes. Sources of noise in sensors and IoT devices: White noise and colored noise models Poisson Processes: Definition of Poisson process, Properties of Poisson process, Counting process and inter-arrival times. Noise Representations: Concept of noise in communication systems, Low-pass noise representation, Band-pass noise representation. Gaussian Process Models for Sensor Measurements, Event Modeling in IoT Using Poisson Processes.	12
Total hours		60

Atleast three simulation experiments should be given as assignment from the below list.

Sl. No.	Experiment
1.	Simulate a random experiment using MATLAB to verify the axioms of probability.
2.	Simulate conditional probability and verify Bayes' Theorem.
3.	Generate a discrete random variable and plot its PMF and CDF.
4.	Simulate two random variables and verify their independence using joint and marginal distributions.
5.	Simulate a function of a random variable, such as $Y=X^2$
6.	Generate a random variable and compute its mean and variance using MATLAB. Verify the results using simulation.
7.	Verify Chebyshev's inequality for a given random variable.
8.	Demonstrate convergence in probability using sample averages of random variables.
9.	Simulate a wide sense stationary (WSS) random process and verify stationarity using mean and autocorrelation plots.
10.	Generate a random process and compute its autocorrelation function using MATLAB.
11.	Verify the Wiener–Khinchine theorem by comparing the autocorrelation function and power spectral density.
12.	Simulate a Gaussian random process and plot its time waveform and histogram.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC161B	IoT Fundamentals and Architecture	PCC	4	0	0	4	2026

1) Course Objectives

To introduce the concept of Internet of Things (IoT), reference layer and various protocols and software. To make the students capable to build IoT systems using sensors, single board computers and open source IoT platforms.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Identify the IoT networking components with respect to OSI layer.	Apply
CO 2	Select IoT protocols and software.	Analyze
CO 3	Evaluate the wireless technologies for IoT	Apply
CO 4	Explain the need for IoT Trust and variants of IoT.	Understand

3) Syllabus

Evolution of IoT, IoT Reference layers and architecture, Characteristics of sensor nodes, IoT Protocols and standards, IoT protocol architecture, wireless technologies related to IoT, Cloud Computation, Big Data Analytics, Open source IoT platforms, IoT threat and security aspects, Web of things, Industrial IoT, Industry 4.0 standards.

4) References

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, “Enabling things to talk – Designing IoT solutions with the 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.
3. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally “Internet of Things A Hands-on-Approach” Arshdeep Bahga & Vijay Madisetti, 2014.
4. Barrie Sosinsky, “Cloud Computing Bible”, Wiley-India, 2010.

5) Course Plan

Module	Contents	No. of hours
I	Evolution of IoT, IPv4 with Network Address Translation, IPV6 addressing, IoT architecture reference layer. Introduction to IoT components, Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open-source hardware, Examples of IoT infrastructure.	12
II	IoT protocols and softwares MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP,COAP, XMPP and gateway protocols.	12
III	IoT point to point communication technologies IoT Communication Pattern, IoT protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BLE, NFC, LORA, Li-Fi, Widi)	11

IV	Introduction to Cloud computation and big data analytics, Evolution of Cloud Computation, Commercial clouds and their features, open source IoT platforms, cloud dashboards, Introduction to big data analytics and Hadoop.	13
V	IoT security - Need for encryption, standard encryption protocol, light weight cryptography, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security, M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0, IoT standards	12
	Total hours	60

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC161C	Principles Of Sensors and Signal Conditioning	PCCP	3	0	2	4	2026

1) Course Objectives

a) To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized and analyzed.

b) To provide in-depth understanding of the principle of measurement and theory of instruments and sensors for measuring velocity and acceleration.

c) To give a fundamental knowledge on the basic laws and phenomena on which operation of sensor transformation of energy is based.

d) To impart a reasonable level of competence in the design, construction, and execution of mechanical measurements strain, force, torque and pressure

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Apply concepts in common methods for converting a physical parameter into an electrical quantity.	Apply
CO 2	Analyze the performance characteristics of intensity Polarization and Interferometric Sensors.	Analyze
CO 3	Compare the performance of various sensors used in real life applications	Apply
CO 4	Design sensor interface circuits for various sensors.	Analyze
CO 5	Explain the principles involved in measuring fluid or gas movement, thermal conditions, and sound characteristics.	Understand

3) Syllabus

Sensor Classification, Performance and Types, Error Analysis characteristics, optical detectors, intensity sensors, microbending concepts, Interferometers, Mach Zehnder, Michelson, Fabry Perot and Sagnac, Phase detection, Polarization maintaining fibers. Different types of Strain, Force, Torque and Pressure sensors. Concepts of LVDT, RVDT, eddy current, transverse inductive, Hall effect, Position, Direction, Displacement and Level sensors. Pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. Flow,

Temperature and Acoustic sensors

4) References

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.
3. Gerd Keiser, “Optical Fiber Communications”,2017,5th edition, McGraw-Hill Science, Delhi.
4. John G Webster, “Measurement, Instrumentation and sensor Handbook”, 2017, 2nd edition, CRC Press, Florida.
5. Eric Udd and W.B. Spillman, “Fiber optic sensors: An introduction for engineers and scientists”, 2013, 2nd edition, Wiley, New Jersey.
6. Bahaa E. A. Saleh and Malvin Carl Teich, “Fundamentals of photonics”, 2012, 1st edition, John Wiley, New York.

5) Course Plan

Module	Contents	No. of hours
I	Sensor fundamentals and characteristics Sensor Classification, Performance and Types, Error Analysis characteristics Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.	9
II	Intensity Polarization and Interferometric Sensors Intensity sensor, Microbending concept, Interferometers, Mach Zehnder, Michelson, Fabry- Perot and Sagnac, Phase sensor: Phase detection, Polarization maintaining fibers.	9
III	Strain, Force, Torque and Pressure sensors -Strain gages, strain gauge 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.	9
IV	Position, Direction, Displacement, Level and Velocity Sensors: 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. Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, monolithic and optical gyroscopes, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes.	9

V	Flow, Temperature and Acoustic sensors Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. Microflow sensor, coriolis mass flow and drag flow sensor. Temperature sensors- thermo resistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor. Acoustic sensors- microphones-resistive, capacitive, piezoelectric, fiber optic, solid state – electrect microphone.	9
	Total hours	**45**

Sl.No.	Experiment
1	Study of Sensor Static Characteristics Calibration of temperature/light sensor; determination of sensitivity, linearity, hysteresis, repeatability.
2	Photodiode Characteristics I–V characteristics in photodiodes
3	Intensity-Modulated Fiber Optic Sensor Measurement of output variation with displacement or bending.
4	Strain Gauge Characteristics Resistance change with applied strain.
5	Piezoelectric Force Sensor Characteristics
6	Potentiometric Displacement Sensor Experiment
7	Hall Effect Sensor Characteristics
8	Ultrasonic Distance Measurement
9	Resistive Microphone Characteristics
10	Piezoelectric Microphone Experiment
Total hours	**30 hours**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26AC061A	Research Methodology & IPR	AC	2	0	0	-	2026

1) Course Objectives

This course is intended to prepare the M. Tech students to carry out their dissertation/ research project work effectively, with a research bias. The student will be able to formulate a viable research problem, do a critical analysis of publications in the area of research, and identify a research method suitable for the work. The student will achieve the capability to write a technical paper based on his/her dissertation/ research project.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO1	Explain research ethics, Citation, Impact factor and Plagiarism.	Apply

CO2	Formulate a research problem, make a suitable research design, and identify the data collection methods.	Apply
CO3	Analyze the collected data.	Analyze
CO4	Explain the role of IPR and Patent law in fostering research work, leading to creation of improved products, thus supporting economic growth and social benefits.	Understand
CO5	Write a technical paper for publication.	Apply

3) Syllabus

Introduction to Research Methodology- motivation for research, types of research, ethical issues. Identifying a research area and collecting related literature. Research problem-scope-objectives, literature review, identifying research gaps, and formulate the research problem. Research design and methods, data collection and analysis. Copy right – royalty - IPR and patent law. Process of patenting and development, Procedure for grant of patents. Copy left- open access, citation, plagiarism, Impact factor. Writing a technical paper.

4) References

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students.
2. Ranjit Kumar, 2nd Edition, Research Methodology: A Step-by-Step Guide for beginners.
3. Ramappa T., Intellectual Property Rights Under WTO, S. Chand, 2008.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, 2016.
5. Mayall, Industrial Design, McGraw Hill, 1992. Niebel, “Product Design”, McGraw Hill, 1974.

5) Course Plan

Module	Contents	No. of hours
I	Introduction to Research Methodology: Motivation towards research, Types of research. Professional ethics in research: Ethical issues, ethical committees. Identification of major conferences and important journals in a chosen area of interest. Collection of at least 10 published papers on a research problem in the chosen area.	6
II	Defining and formulating the research problem: Literature Survey, Analyzing the collected papers to understand how the authors have identified the research gaps, arrived at their objectives, and formulated their research problem. Understanding how their research work is different from the previous works in the chosen area.	6
III	Research design and methods: Analyzing the collected papers to understand how the authors have formulated the research methods, both analytical methods and experimental methods. Data Collection and analysis: Analyzing the collected papers to understand the methods of data collection, data processing, analysis strategies, and tools used for analyzing the data.	6

IV	Copy right - royalty - Intellectual property rights and patent law – Process of Patenting and Development, Procedure for grant of patents. Reproduction of published material: Copy left- Open access, Citation and acknowledgement. Plagiarism, Impact factor.	6
V	Technical writing - Structure and components of a typical technical paper, abstract and conclusion, illustrations and tables, bibliography, referencing and footnotes. Writing a technical paper – based on the identified research problem, and using the collected papers, Literature survey, Problem formulation, and Research design, and a hypothetical result.	6
Total hours		**30**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC169A	IoT Data Acquisition and Analysis Lab	LBC	0	0	3	2	2026

1) Course Objectives

To explore the fundamentals of data acquisition using sensors and to enable students to measure, generate, and synchronize data acquisition tasks and analyze the data in MATLAB/ LabVIEW. To perform data acquisition using Arduino.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Develop PC-based data acquisition and signal conditioning.	Apply
CO 2	Implement techniques to control the analog input, analog output, counter/timer, and digital I/O subsystems of a DAQ device.	Apply
CO 3	Perform different types of data acquisition and identify the correct sensor for their measurements.	Apply
CO 4	Acquire data from sensors and analyse the results	Apply

3) List of experiments

Sl. No	Experiment
1	Familiarization of data Acquisition toolbox in Matlab.
2	Acquire and characterize analog and digital signals
3	Measure frequency, pulse width and count pulses
4	Generate Pulse Width Modulated signal
5	Acquire and characterize audio signals
6	Simultaneous and synchronized data acquisition
7	Simulink data acquisition
8	Arduino based multi-channel data acquisition

SEMESTER II

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC161D	Microcontrollers for IoT	PCCP	3	0	2	4	2026

1) Course Objectives

1. Introduce low power microcontrollers and to develop the skill set of programming low power sensing applications.
2. Impart the knowledge of various peripheral related to sensing and communication using wired or wireless means.
3. Upgrade the students by introducing them Advanced ARM Cortex microcontrollers
4. Develop The Skill Set of Students to Build IoT Systems and Sensor Interfacing

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Explain the architecture of microcontrollers for IoT applications.	Understand
CO 2	Demonstrate the use of MSP430 architectural features to implement basic embedded system tasks.	Apply
CO 3	Develop programs for ARM Cortex M microcontroller applications.	Apply
CO 4	Design IoT systems using Microcontrollers.	Apply
CO 5	Use the architecture of the VEGA THEJAS32 microcontroller for IoT and embedded systems.	Apply

3) Syllabus

Introduction to Embedded system, Microcontroller Vs Microprocessor
Instruction Set, Examples, Reflections on the CPU and Instruction Set, Exceptions, Clock system. Development: Development Environment, Access to the Microcontroller for Programming and Debugging, Demonstration Boards, Examples.
Functions, Interrupts, and Low-Power Modes. Functions and Subroutines, Interrupts, ISR, Low-Power Modes of Operation ARM Cortex M: Architecture, operating modes, software development process. Assembly language: syntax, addressing modes and operands instruction set, logical and arithmetic operations, stack, functions and control flow, Assembler directives, Examples. Introduction to input/output: TI micro controller input/output pins, Texas Instruments TM4C123 LaunchPad I/O pins, Basic concept of input output pins, PLL.
Sensors interfacing: Sensors interfacing techniques- Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11Cloud interfacing: Interfacing and data logging with cloud: Thing speak.
VEGA THEJAS32 Microcontroller: RISC-V Instruction Set Architecture, Registers, Operating Modes, Programmers' Model for Base Integer ISA, Base Instruction Formats, Exceptions, Traps, and Interrupts, Machine-Level CSRsTHEJAS32 Microcontroller: Functional Bock

diagram, CPU, Memory Mapped input output and Interrupts

4) References

1. John H. Davies, “MSP430 Microcontroller Basics”, 2011, 2nd ed., Newnes publishing, 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.
4. Sergey Y. Yurish,”Digital Sensors and Sensor Systems: Practical Design”, 2011, 1st ed., IFSA publishing, New York
5. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2014, 4th ed., Springer, New York.
6. RISC_V ISA Manual, “Volume 1, Unprivileged Spec v. 20191213 “
7. THEJAS32 Datasheet

5) Course Plan

Module	Contents	No.of hours
I	Introduction: Embedded system, Microcontrollers vs Microprocessor, Anatomy of a Microcontroller. MSP430 Microcontrollers: Functional Block diagram, Memory, CPU, addressing modes, Constant Generator and Emulated Instructions, Instruction Set, Examples, Reflections on the CPU and Instruction Set, Exceptions: interrupt and Resets, Clock system.	9
II	Development: Development Environment, Access to the Microcontroller for Programming and Debugging, Demonstration Boards, Examples: Light LEDs in C, Read Input from a Switch. Functions, Interrupts, and Low-Power Modes. Functions and Subroutines, Interrupts, ISR, Low-Power Modes of Operation.	9
III	ARM Cortex M: Architecture, register, memory, operating modes, software development process. Assembly language: syntax, addressing modes and operands, memory access instructions, logical operation, Arithmetic operation, stack, functions and control flow, Assembler directives, Examples, Simplified machine language execution.	9
IV	ARM board Sensor’s interfacing: Sensors interfacing techniques-Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11. Cloud interfacing: Interfacing and data logging with cloud: Thing speak Introduction to input/output: TI micro controller input/output pins, Texas Instruments TM4C123 Launch Pad I/O pins, Basic concept of input output pins,PLL, Standard I/O driver and printf function, Debugging.	9

V	VEGA THEJAS32 Microcontroller: RISC-V Instruction Set Architecture, Registers – General Purpose Registers, Control and Status Registers, Operating Modes, Programmers' Model for Base Integer ISA, Base Instruction Formats, Exceptions, Traps, and Interrupts,Machine-Level CSRs misa, mhartid, mstatus, mtvec medeleg and mideleg, mip and mie, mepc, mcause, mtval. THEJAS32 Microcontroller: Functional Bock diagram, CPU, Memory Mapped input output and Interrupts, Demonstration Boards- ARIES V2.0	9
	Total hours	**45**

Lab experiments:

No.	Description	hours
1	Introduction to Integrated Development Environment – Code Composer Studio/ IAR Embedded Workbench, familiarization of instruction set.	6
2	LED blinking (with and without using timers for delays), switch interfacing, timers and interrupts, PWM generation, ADC Interfacing, Sensors interfacing, Low power mode operation.	6
3	Familiarization of IDE (Keil µVision) for ARM, Basic assembly language programs for instruction set familiarization	6
4	LED blinking and switch interfacing, Timer Interrupt and External Interrupt generation, PWM generation, ADC Interfacing using Sensors, Serial Communication, Motor Interfacing.	6
5	Familiarization of IDE (Arduino IDE for Ariesv3), Digital I/O control using GPIO (LED and switches), PWM Signal Generation for LED brightness and motor speed control, Reading Analog sensor values and displaying on serial monitor, Sensor's Interfacing, Motor Interfacing.	6
	Total	30 hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC167A	Mini Project	PR	0	0	6	3	2026

1) Course Objectives

Goal of this course is to enable students to take up small problems in their field of study as mini project and collect the recent publications related to the topic and present the observations and findings related to the project work.

2) Course Outcomes

After the completion of the course, the student will be able to:

#	Description	Level
CO 1	Implement a designed system or application by identifying and solving problems in the field of study.	Apply
CO 2	Test the designed system or application.	Evaluate
CO 3	Develop effective written and oral communication	Create

CO 4	Explore domains of interest so as to pursue the course project.	Analyze

3) Approach

1) Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project.
2) Students shall make a presentation for 20-25 minutes based on the detailed study on the project and submit a report of the study.
3) Demonstrate the novelty of the project through the results and outputs
4) The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC169B	IoT and Sensor Systems Lab	LBC	0	0	3	2	2026

1) Course Objectives

The main objective of this course is to know the different real time sensors which could be used for real time automation and to understand the connectivity and configuration of various modules used in IOT.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Explore ideas to carry out research / investigation independently to solve practical problems through real time automation.	Apply
CO 2	Programming using Arduino and Raspberry-Pi modules.	Apply
CO 3	Programming of Arduino modules with the integration of various peripherals for real time automation.	Apply
CO 4	Programming of Raspberry-Pi modules with the integration of various peripherals for real time automation.	Apply

3) List of Experiments

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

9	Design an IoT based system for industrial applications.

PROGRAM ELECTIVES

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162A	Flexible and Wearable Sensors	PEC	3	0	0	3	2026

1) Course Objectives

To impart the importance of flexible electronics and wearable sensors to provide a brief overview of wearable technology and its impact on social life.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO1	Explain the processing steps involved in the fabrication of flexible electronic circuits.	Understand
CO2	Describe the fabrication techniques of thin film transistor	Understand
CO3	Compare various types of wearable haptics, bio and chemical sensors	Apply
CO4	Interpret the parameters obtained from various body-worn sensors.	Apply
CO5	Design low power circuits for implementing wearable biopotential sensor systems.	Apply

3) Syllabus

Materials for Flexible Electronics, Thin-film Deposition and Processing Methods for Flexible Devices

Thin Film Transistors: materials and technologies, review of semiconductors employed in flexible electronics.

Wearable Haptics, Wearable Bio and chemical sensors, Wearable inertial sensors, Measurement of energy expenditure by body-worn devices, Low power analog/digital integrated circuit design techniques for wearable biopotential sensors

4) References

1. Edward Sazonov and Michael R. Neuman, “Wearable Sensors -Fundamentals, Implementation and Applications”, Elsevier Inc.,2014.

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

3. “Wearable and Autonomous Biomedical Devices and Systems for Smart Environment”, by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010.

4. Seamless Healthcare Monitoring”, Toshiyo Tamura and Wenxi Chen, Springer 2018.

5. Guozhen Shen, Zhiyong Fan, “Flexible Electronics: From Materials to Devices”, 2015, 1st Edition, World Scientific Publishing Co, Singapore.

5) Course Plan

Module	Contents	No. of hours
	Overview of Flexible Electronics Technology: Materials for Flexible Electronics: Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, structure and property relationships. Thin-film	

I	Deposition and Processing Methods for Flexible Devices CVD, PECVD, PVD, etching, photolithography, low- temperature process integration.	9
II	Thin Film Transistors: materials and technologies, review of semiconductors employed in flexible electronics, thin film transistors based on a-IGZO, plastic electronics for smart textiles.	8
III	World of Wearable(WOW):The emergence of wearable computing and wearable electronics, Attributes of wearable's, types of wearable sensors: Invasive, Non- invasive; intelligent clothing, Industry sector's overview- sports, healthcare, fashion and entertainment, military, environment monitoring, mining industry, public sector and safety; Wearable Haptics: The need for wearable haptic devices, categories of wearable haptic and tactile display; Wearable Bio and chemical sensors: system design, challenges in chemical biochemical sensing, application areas.	10
IV	Wearable inertial sensors and their applications, parameters obtained from inertial sensors, Practical considerations for wearable inertial sensor applications in clinical practice; Measurement of energy expenditure by body-worn devices, design considerations	9
V	Biopotential signals and their characteristics, electrode- body interface and electrode noise; Measurement of energy expenditure by body-worn devices, design considerations; Low power analog/digital integrated circuit design techniques for wearable bio potential sensors; Architectural design for low-power bio potential acquisition. Practical considerations.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162B	MICRO AND NANO FLUIDICS	PEC	3	0	0	3	2026

1) Course Objectives

Discuss the fundamental physics of micro and nano scale fluids and their hydrodynamics.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Apply the fundamental physics of micro and nano scale fluids.	Apply
CO 2	Explain the hydrodynamic of micro and nano scale fluids.	Understand
CO 3	Discuss the fabrication techniques of microfluidics devices.	Understand
CO 4	Interpret the working principle of various existing microfluidic devices.	Apply
CO 5	Develop various microfluidic lab-on-chip applications.	Apply

3) Syllabus

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

Patterning, Photolithography, Micromachining, Micromolding, Soft Microfluids, Active Flow control, Microvalves, electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers. Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment. Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction and Parallel reaction in micro reactors, chemical separation, liquid chromatography

4) References

1. Clement Kleinstreuer, "Micro fluidics and Nanofluidics: Theory and Selected Applications",2013, 1st ed., John Wiley & Sons, New Jersey
2. Shaurya Prakash, Junghoon Yeom, "Nanofluidics and Microfluidics: Systems and Applications",2014, 1st ed., William Andrew; Norwich, New York.
3. Albert Folch, "Introduction to BioMEMS", 2012, 1st ed., CRC Press, United Kingdom.
4. Patrick Tabeling, "Introduction to Microfluidics", 2011, Reprint ed., Oxford University Press, Great Britain.
5. Xiujun James Li, Yu Zhou, "Microfluidic Devices for Biomedical Applications", 2013, 1st ed., Wood head Publishing, Cambridge.
6. Terrence Conlisk. A, "Essentials of Micro- and Nanofluidics: With Applications to the Biological and Chemical Sciences", 2012, 1st ed., Cambridge University Press, New York.

5) Course Plan

Module	Contents	No.of hours
I	Fundamentals for Microscale and Nanoscale Flow Fluids and non-fluids, properties of fluids, classification of fluids, Newtonian and Non-Newtonian fluids, pressure driven flow, Reynolds number, Electro kinetic 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.	10
II	Hydrodynamics: Introduction to surface, surface charge, surface energy, Thermodynamics of surfaces, Fluids in Electrical fields, The Navier Strokes equation, Boundary and Initial conditions problems	8
III	Fabrication methods and techniques Patterning, Photolithography,Micromachining, Micromolding, Soft lithography, PDMS properties, Fabrication of microfludics channels	9
IV	Microfluidic Devices Droplet Microfluids, Active Flow control, Microvalves, electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers	9

V	Microfluidics Lab on Chip Microfluidic for Flow cytometry, cellsorting, cell trapping, Cell culture in microenvironment Bioreactors on Microchips. Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction and Parallel reaction in micro reactors, chemical separation, liquid chromatography.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162C	Machine Learning	PEC	2	0	2	3	2026

1) Course Objectives

To enable analyzing data using intelligent techniques and to provide an in- depth introduction to machine learning algorithms.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Apply various learning approaches to interpret the concepts of supervised and unsupervised learning techniques.	Apply
CO 2	Apply parametric models for regression and classification problems using Linear Regression, Logistic Regression, Gradient Descent, and Bayesian learning principles.	Apply
CO 3	Apply shallow neural network models using gradient-based learning and backpropagation to evaluate their performance using appropriate loss functions, regularization, risk minimization techniques, and confusion matrix.	Apply
CO 4	Apply classical machine learning algorithms such as Decision Trees, SVMs, Ensemble methods (Bagging, Boosting, Voting), Hidden Markov Models, and Clustering techniques, including dimensionality reduction using PCA.	Apply
CO 5	Illustrate various clustering algorithms, and apply machine learning solutions to real-world engineering case studies across multiple domains.	Apply

3) Syllabus

Introduction to Machine learning, Learning in Artificial Neural Networks, Classification and regression – decision trees, Baye's theorem, MLE, etc., Feedforward networks, Back propagation algorithms, Kernel machines, Discrete Markov Processes, Model combination schemes, clustering algorithms and other Supervised and Unsupervised learning methods.

4) References

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Ethem Alpaydın, "Introduction to Machine Learning (Adaptive Computation and Machine Learning)", MIT Press, 2004.
3. Margaret H. Dunham. "Data Mining: introductory and Advanced Topics", Pearson, 2006.
4. Mitchell. T, "Machine Learning", McGraw Hill.

5. Ryszard S. Michalski, Jaime G. Carbonell, and Tom M. Mitchell, "Machine Learning: An Artificial Intelligence Approach", Tioga Publishing Company.

5) Course Plan

Module	Contents	No. of hours
I	Introduction to Machine Learning, Supervised and unsupervised learning, parametric vs non- parametric models, parametric models for classification and regression- Linear Regression, Logistic Regression, Review of probability/Linear Algebra, Gradient Descent Algorithm (mathematical interpretation)	5
II	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.	6
III	Classification- Cross validation and re-sampling methods- K-fold cross validation, Boot strapping, Measuring classifier performance- Precision, recall, ROC curves. Baye's Theorem, Bayesian classifier, Maximum Likelihood estimation, Density functions. Decision Trees- Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning	7
IV	Kernel Machines- Support Vector Machine- Optimal Separating hyperplane, Soft-margin hyperplane, Kernel trick, Kernel functions. Discrete Markov Processes, Hidden Markov models, three basic problems of HMMs, Evaluation problem, finding state sequence, Learning model parameters. Combining multiple learners, Model combination schemes, Voting, Bagging, and Boosting.	7
V	Clustering- distance based K-means, density based, association rule mining, Eigen values, Eigen vectors, Dimensionality reduction techniques – PCA. Evaluation parameters of a classifier from the confusion matrix. Orthogonality- challenges motivating deep learning. Case Study -Application of Machine learning in different Engineering Sectors.	5
	Total hours	**30**

List of experiments:

1	Familiarization with the simulation tool
2	Data Visualization and preprocessing
3	Implementation of Linear Regression
4	Predicting popularity of comments using logistic regression, visualization of

	decision boundary
5	Decision tree construction using ID3
6	Implementation of perceptron algorithm on different kinds of datasets, XOR classification using MLP
7	Dimensionality reduction: Principal Component Analysis
8	Prediction of rainfall at different locations using ensemble methods
9	Protein structure classification using SVM, Standard and user-defined kernel functions for non-linearly separable datasets
10	K-means clustering for different real datasets, choosing correct value of "K"
Total hours	**30 hours**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162D	Automotive Sensors and In-Vehicle Networking	PEC	3	0	0	3	2026

1) Course Objectives

The objective of this course is

a) Acquaint with the basic automotive parts and the need for sensor integration in different automotive systems

b) Discuss the basics of various Powertrain sensors and associated systems for proper vehicle dynamics and stability in automotive systems.

c) Comprehend various sensors for vehicle body management and discuss various sensors and technologies for passenger convenience, safety and security systems

d) Acquaint various communication standards and protocols followed within the automotive systems

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Identify the basic automotive parts and the requirement of sensors and their integration in different automotive systems.	Apply
CO 2	Identify the basics of various Powertrain sensors.	Apply
CO 3	Comprehend and analyse various systems like ABS, ESP, TCS, etc. for understanding vehicle dynamics and stability.	Analyze
CO 4	Comprehend the various sensors for vehicle body management, convenience & security systems.	Analyze
CO 5	Identify various technologies developed for passenger convenience, Air Bag deployment and Seat Belt Tensioner System, etc. with the students	Apply

CO6	Recognize various communication standards and protocols followed within the automotive systems.	Apply

3) Syllabus

Introduction to Automotive Engineering, Automotive Management systems, Powertrain Sensors and Sensors for Chassis management, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Air Bag and Seat Belt Pre tensioner Systems, Passenger Convenience Systems, Modern Trends and Technical Solutions.

4) References

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

5) Course Plan

Module	Contents	No. of hours
I	Introduction to Automotive Engineering, Automotive Management systems: Powertrain, 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 automotive industry, Enabling technologies and Industry trends	8
II	Powertrain Sensors and Sensors for Chassis management: λ sensors, exhaust temperature sensor, NOx sensor, PM sensor, fuel quality sensor, level sensor, torque sensor, speed sensor, mass flow sensor, manifold pressure sensor. Wheel speed sensors/direction sensors, steering position sensor (multi turn), acceleration sensor (inertia measurement), brake pneumatic pressure sensor, ABS sensor, electronic stability sensor.	10
III	Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems: Gas sensors (CO_2), Temperature/humidity sensor, air bag sensor, keyless 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.	9

IV	Air Bag and Seat Belt Pre tensioner Systems, Passenger Convenience Systems: Principal Sensor Functions, Distributed Front AirBag sensing systems, Single-Point Sensing systems, Side-Impact Sensing, and Future Occupant Protection systems. Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Tire Pressure Control Systems, Electromechanical Window Drives, etc.	9
V	Modern Trends and Technical Solutions: Enabling Connectivity by Networking: In vehicle communication standards (CAN & LIN), Telematics 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.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162E	Cloud and Fog Computing	PEC	3	0	0	3	2026

1) Course Objectives

- To introduce the concepts and security issues of the cloud paradigm.
- To give awareness about the public cloud platforms.
- To understand the fundamentals of fog computing.

2) Course Outcomes:

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Interpret the various cloud computing models and services	Apply
CO 2	Compare the various public cloud platforms and software environments.	Apply
CO 3	Discuss the need of security mechanisms in cloud.	Apply
CO 4	Explain the concepts of fog computing.	Understand
CO 5	Illustrate the various applications using cloud and fog computing.	Apply

3) Syllabus

Introduction to Cloud Computing: Basics of cloud computing-concepts and models, -cloud architecture standards - Cloud types- Benefits and challenges of cloud computing, role of virtualization in enabling the cloud.

Cloud Architecture and Resource Management: Architectural Design of Compute and Storage Clouds – Public Cloud Platforms: Emerging Cloud Software Environments - Extended Cloud Computing Services.

Security in the Cloud: Security Overview – Cloud Security Challenges –Risk Management - Security Monitoring – Security Architecture Design – Data Security -Application Security – Virtual machine Security.

Introduction to fog computing: Fog Computing and Internet of Things-Pros and Cons - Need

and Reasons for Fog Computing- Fog Computing and Edge Computing
Recent Trends in cloud computing – Case study

4) References

1. Kai Hwang, Geoffrey C Fox, Jack J Dongarra: Distributed and Cloud Computing- From Parallel Processing to the Internet of things, Morgan kaufmann Publishers -2012.
2. B. Sosinsky, Cloud Computing Bible, Wiley India, 2011.
3. R. Buyya, C. Vecchiola and S. T. Selvi, Mastering Cloud Computing, McGraw Hill, 2013.
4. Ivan Stojmenovic, Sheng Wen,"The Fog Computing Paradigm: Scenarios and Security Issues" Proceedings of the 2014 Federated Conference on Computer Science and Information Systems pp. 1–8
5. Rajkumar Buyya, Satish Narayana Srirama, Fog and Edge Computing: Principles and Paradigms,Wiley, 2019.

5) Course Plan

Module	Contents	No.of hours
I	Introduction to Cloud Computing. Basics of cloud computing-Need for clouds- concepts and models,-cloud architecture standards and interoperability- Cloud types- IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public, private clouds community cloud, role of virtualization in enabling the cloud.	9
II	Cloud Architecture and Resource Management Architectural Design of Compute and Storage Clouds – Public Cloud Platforms: GAE- AWS -Azure- Emerging Cloud Software Environments - Eucalyptus- Nimbus - Open Stack – Extended Cloud Computing Services – Resource Provisioning and platform Deployment- Virtual machine Creation and management.	10
III	Security in the Cloud Security Overview – Cloud Security Challenges – Security as a Service – Security Governance – Risk Management -Security Monitoring – Security Architecture Design – Data Security - Application Security – Virtual machine Security.	8
IV	Introduction to fog computing Fog Computing-Definition-Characteristics-Application Scenarios - Issues -Fog Computing and Internet of Things-Pros and Cons- Myths of Fog Computing -Need and Reasons for Fog Computing Fog Computing and Edge Computing-IoT, FOG, Cloud Benefits.	9
V	Recent Trends in cloud computing Case study: Smart Traffic Light System, Wearable Sensing Devices, Wearable Event Device, Wearable System, Demonstrations, Post Application Example. Event Applications Example, Big Data Analytics for Healthcare Applications, Big Data Analytics for Social Media Applications, Serveless infrastructures, Edge cloud, CloudAI	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162F	IoT Security and Trust	PEC	3	0	0	3	2026

1) Course Objectives

This course aims to impart the knowledge and technical skills in designing secured and trustable IoT systems.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Design and implement cryptography algorithms using C programs.	Analyze
CO 2	Solve network security problems in various networks.	Analyze
CO 3	Build security systems using elementary block.	Analyze
CO 4	Build Trustable cloud based IoT systems and solve IoT security problems.	Analyze
CO 5	Appreciate the need for cyber security laws and methods.	Analyze

3) Syllabus

Fundamentals of encryption for cyber security, IoT security framework, Elementary blocks of IoT Security & Models for Identity Management, Identity Management and Trust Establishment, Access Control in IoT, Security and Digital Identity in Cloud Computing, Cyber Crimes, Hackers and Forensics.

4) References

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, SamiaBouzefrane,“Digital Identity Management”, Elsevier, 2015.
4) Joseph Migga Kizza, “Computer Network Security”, Springer, 2005.

5) Course Plan

Module	Contents	No. of hours
I	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) Block cipher.	8
II	IIOT security frame work, Security in hardware, Boot process, 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.	8

III	Vulnerability of IoT and elementary blocks of IoT Security, Threat modelling – Key elements. Identity management Models and Identity management in IoT, Approaches using User-centric, Device-centric and Hybrid, Side channel analysis.	10
IV	Trust management lifecycle, Identity and Trust, Web of trust models. Establishment: Cryptosystems – Mutual establishment phases – Comparison on security analysis. Identity management framework. Capability-based access control schemes, Concepts, identity-based and identity-driven, Light weight cryptography, need and methods.	9
V	Cloud security, Digital identity management in cloud, Classical solutions, alternative solutions, Management of privacy and personal data in Cloud. Cyber Crimes and Laws – Hackers – Dealing with the rise tide of Cyber Crimes – Cyber Forensics and incident Response – Network Forensics.	10
	Total Hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162G	Biomedical Sensors	PEC	3	0	0	3	2026

1) Course Objectives

This course aims at introducing the student to sensors used in different biomedical applications.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Explain the requirements, calibration, characteristics and parameters of biomedical sensors.	Understand
CO 2	Illustrate the operating principle and applications of resistive, reactance and electromagnetic sensors.	Understand
CO 3	Compare the different parameters and models of various self-generating sensors.	Apply
CO 4	Apply the knowledge of the features of optical and ultrasound sensors for various biomedical applications.	Apply
CO 5	Apply the principles of biosensors and intelligent sensors to select appropriate sensors for different biomedical applications.	Apply

3) Syllabus

Introduction to Biomedical Sensors: Sensor classification and calibration, static and dynamic characteristics, errors and uncertainty. Resistive Sensors, Reactance Variation and Electromagnetic Sensors: Thermistors, light- dependent resistors, Capacitive sensors, Inductive sensors, Electromagnetic sensors

Self-Generating Sensors: Thermoelectric sensors, Piezoelectric sensors, Electrochemical

sensors, Signal conditioning for self-generating sensors.
Optical and Ultrasound Sensors: Optical techniques, General principles of optical sensing, Fiber-optic sensor technologies and applications. Ultrasonic- based sensing methods and applications.
Biosensors and Intelligent Sensors: Operating principle, biological elements in biosensors, applications. Intelligent Sensors: Definition, parameters, features, operating principle, main building blocks and applications.

4) References

1) Yang, V. C., and Ngo, T. T., (2000), Biosensors and their Applications, Kluwer Academic/Plenum Publisher, New York.
2) Hall, E. A., (1990), Biosensors, Open University Press, Milton Keynes
3) Mehrotra, Parikha. "Biosensors and their applications - A review." Journal of oral biology and craniofacial research vol. 6,2 (2016)
4) Naresh V, Lee N. A Review on Biosensors and Recent Development of Nanostructured Materials-Enabled Biosensors. Sensors. 2021; 21(4)
5) Harsanyi, G , (2000), Sensors in Biomedical Applications: Fundamentals, Technology and Applications, Technomic Publishing Company.

5) Course Plan

Module	Contents	No. of hours
I	Introduction to Biomedical Sensors: Sensor classification and calibration, static and dynamic characteristics, errors and uncertainty.	8
II	Resistive Sensors, Reactance Variation and Electromagnetic Sensors: Thermistors, light-dependent resistors, Capacitive sensors, Inductive sensors, Electromagnetic sensors.	9
III	Self-Generating Sensors: Thermoelectric sensors, Piezoelectric sensors, Electrochemical sensors, Signal conditioning for self-generating sensors. Case studies on self-generating sensors.	9
IV	Optical and Ultrasound Sensors: Optical techniques, General principles of optical sensing, Fiber-optic sensor technologies and applications. Ultrasonic-based sensing methods and applications. Case studies on optical and ultrasound sensors.	9
V	Biosensors and Intelligent Sensors: Operating principle, biological elements in biosensors, applications. Intelligent Sensors: Definition, parameters, features, operating principle, main building blocks and applications. Case study: Lab-on-a–chip.	10
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162H	RF MEMS	PEC	3	0	0	3	2026

1) Course Objectives

The goal of this course is to provide an insight to the students on the fundamentals of RF

MEMS circuit elements, MEMS based circuit design.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Analyse the different MEMS technologies and the need for packaging.	Apply
CO 2	Analyse the various actuation mechanisms and design consideration for RF MEMS switches.	Apply
CO 3	Explain the operation of inductors and capacitors.	Understand
CO 4	Describe the working of RF MEMS Phase Shifters, Filters, Oscillators	Understand
CO 5	Discuss the concepts of micro machined antennas.	Understand

3) Syllabus

Introduction to RF MEMS- application.

Introduction to Micro fabrication Technique-Material properties, Bulk and surface micromachining, Wet and dry etching, Thin-film depositions, design and testing.

Actuation Mechanisms in MEMS, RF MEMS switches and applications, Introduction to MEMS switch design and its analysis.

Integration and biasing issues for RF switches, Example of RF MEMS switches and applications, Mechanical design, Electromagnetic modelling.

Micro machined inductors, variable inductors, polymer-based inductors, gap- tuning and area tuning capacitors, dielectric tuneable capacitors.

Resonators – applications in oscillators and filters- Modelling of mechanical filters. Introduction to Micromachined antennas, design parameters and RF

4) References

1. RF MEMS and Their Applications", Vijay Varadan, K. J. Vinoy, K. A. Jose, Wiley, 2003.
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2017.
3. Chang Liu, Foundations of MEMS, Pearson 2012
4. "RF MEMS: Theory, Design, and Technology", Gabriel M. Rebeiz, Wiley, 2003
5. "RF MEMS Circuit Design for Wireless Applications", Hector J. De Los Santos, Artech House, 2002

5) Course Plan

Module	Contents	No. of hours
I	Introduction to RF MEMS, application in wireless communications; Overview of RF MEMS fabrication. Introduction to Micro fabrication Techniques- Materials properties, Bulk and surface micromachining, Wet and dry etching, Thin-film depositions, design and testing.	9
II	Actuation Mechanisms in MEMS- Piezoelectric, Electrostatic, Thermal, Magnetic.RF MEMS switches and applications- Integration and biasing issues for RF switches. MEMS switch design, Example of RF MEMS switches and applications, Mechanical design, Electromagnetic modelling (Capacitance, Loss, Isolation modelling and analysis- Electromechanical finite element analysis, RF design.	9

III	Inductors and capacitors - micro machined inductors, variable inductors, polymer-based inductors, gap-tuning and area tuning capacitors, two plate and three plate configuration, dielectric tuneable capacitors.	9
IV	Resonators –applications in oscillators and filters- Modelling of mechanical filters. Electrostatic comb drive. Micromechanical filters using comb drives. Electrostatic coupled beam structures, Surface Acoustic Wave Filters, Film bulk acoustic wave resonators.	9
V	Micro machined antennas – design parameters. Micromachining to improve performance. Reconfigurable antennas. RF NEMS-overview. Integration and Packaging: Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162I	Wireless Sensor Networks and IoT	PEC	3	0	0	3	2026

1) Course Objectives

This course aims to expose the students to the central elements in the design of communication protocols for the WSNs and design knowledge in analyzing the specific requirements for applications in WSNs. It also aims to design simple IoT systems comprising sensors, edge devices, wireless network connections, data analytics capabilities and cloud storage.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Explain the basics concepts of Wireless Sensor Network architecture and its principles.	Understand
CO 2	Explain the various communication protocols in WSN stack.	Understand
CO 3	Apply the concepts of localization and time synchronization.	Apply
CO 4	Use open-source tools for the implementation of WSN.	Apply
CO 5	Design simple IoT systems comprising sensors, edge devices, wireless network connections, data analytics capabilities and cloud storage.	Apply

3) Syllabus

Comparison of sensor network with ad hoc network, Single node architecture, Network architecture, Physical layer and transceiver design consideration in wireless sensor networks, Fundamentals of wireless MAC protocols, Routing protocols, Localization and positioning, Time synchronization problem, Tiny Operating System, Contiki OS, Event-Driven Programming, building blocks of an IoT device, interfacing using any Embedded

target boards, Cloud Support, Web server, Data Analytics for IoT.

4) References

1. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks” 2011, 1st ed., John Wiley & Sons, New Jersey.
2. Fei Hu and Xiaojun Cao, “Wireless Sensor Networks Principles and Practice”, CRC Press,2010.
3. Feng Zhao and Leonidas Guibas, “Wireless Sensor Networks: an Information Processing Approach”, Elsevier Publication, 2004.
4. Honbo Zhou, "The Internet of Things in the Cloud : A Middleware Perspective", CRC Press, 2012.
5. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands- on Approach", Universities Press, 2014.
6. Matt Richardson & Shawn Wallace, “Getting Started with Raspberry Pi”, O'Reilly Media Press, 1st Edition, 2012.
7. AgusKuniawa, "Getting started with Intel IoT and Intel Galileo", Kindle Edition, 2015.
8. Sitharama Iyengar S, Nandan Parmeshwaran, Balkrishnan N and Chuka D, “Fundamentals of Sensor Network Programming, Applications and Technology”, John Wiley & Sons, 2011.

5) Course Plan

Module	Contents	No.of hours
I	Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture, Hardware components, Energy consumption of sensor nodes, Network architecture: Sensor network scenarios, Optimization Goals and Design principles. Physical layer and transceiver design consideration in wireless sensor networks.	9
II	Fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols. ROUTING PROTOCOLS - Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, Data centric routing, Data aggregation.	10
III	Localization and positioning: Possible approaches, single hop localization, positioning in multi-hop environments. Time synchronization: Time synchronization problem, protocols based on sender to receiver and receiver to receiver synchronization in WSN.	8
IV	Programming Challenges in Wireless Sensor Networks, Tiny Operating System, Contiki OS, Event-Driven Programming, Techniques for Protocol Programming.	9
V	Building blocks of an IoT device - Programming Inputs and outputs, Serial, SPI and I2C - Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)*. Cloud Support: Cloud Storage models and communication APIs. Web server - Web	9

	server for IoT - Cloud for IoT - Designing a RESTful web API - Amazon Web services for IoT - Data Analytics for IoT: Apache Hadoop - Using map reduce for batch data analytics.	
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162J	IoT Applications and Web development	PEC	3	0	0	3	2026

1) Course Overview:

This course offers a comprehensive foundation in web technologies and JavaScript, progressing from HTML and CSS basics to dynamic, user-centered web application development. It further introduces IIoT fundamentals and big data concepts, bridging web development skills with real-world industrial and IoT applications.

2) Course Outcomes:

After the completion of the course, the student will be able to:

#	Description	Level
CO 1	Apply HTML and CSS fundamentals to create well-structured, semantic, and visually styled web pages.	Apply
CO 2	Design responsive and user-centered web interfaces using advanced CSS techniques, dynamic content concepts, image design tools, and established UX principles.	Apply
CO 3	Develop interactive web applications using JavaScript by implementing DOM manipulation, event handling, object usage, and client-side form validation.	Apply
CO 4	Explain the fundamentals of Industrial IoT systems, including components, manufacturing applications, monitoring, control, and the role of big data analytics.	Understand
CO 5	Analyze and apply IoT architectures to real-world domains such as smart farming, energy management, healthcare, and smart cities to design application-level solutions.	Apply

3) Syllabus

Introduction to markup languages and HTML. Structure of HTML documents, semantic elements, and content organization. HTML forms and form controls. Basics of Cascading Style Sheets (CSS) including inline, internal, and external styles.

Advanced CSS concepts including layouts and responsive design. Use of multiple CSS style sheets and cascading rules. Introduction to Dynamic HTML (DHTML). Tools for image creation and manipulation for web. User Experience (UX) Design Principles of user-centered design, Information architecture and navigation design, Wire framing and prototyping fundamentals, Usability testing and accessibility standards.

Basic JavaScript syntax, variables, data types, operators, and control structures. Simple JavaScript programs and understanding script execution in web pages. Document Object Model (DOM) and accessing HTML elements using JavaScript. Handling user events such as clicks, key presses, and form submissions. Object handling in JavaScript. HTML forms using JavaScript. Client-side input validation techniques for text fields, numbers, email, and passwords. Error handling and feedback. Industrial Manufacturing, Monitoring,

Control, Optimization and Autonomy, Introduction to Hadoop and big data analytics Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides. Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, Data lake services scenarios. Architecture of IoT for Healthcare Applications.

4) Reference

1. John Dean, Web Programming with HTML5, CSS and JavaScript, 2018, Jones and Bartlett Publishers Inc., ISBN-10: 9781284091793
2. DiMarzio J. F., Beginning Android Programming with Android Studio, 2016, 4th ed., Wiley, ISBN-10: 9788126565580
3. Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRC Press, ISBN-10: 1138316849
4. Giacomo Veneri, and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, 2018, Packt Publishing.
5. Wiely,F Hasan, Internet Of Things A To Z: Technologies And Applications,IEEE press.
6. Subhas Chandra Mukhopadhyay, Smart Sensing Technology for Agriculture and Environmental Monitoring, 2012, Springer, ISBN-10: 3642276377
7. Vankamamidi S. Naresh1, Suryateja S. Pericherla, Pilla Sita Rama Murty, Sivaranjani Reddi, Internet of Things in Healthcare: Architecture, Applications, Challenges, and Solutions, International Journal of Computer Systems Science &Engineering, vol 35 no 6 November 2020

5) Course plan

Module	Contents	No.of hours
I	Web Markup and HTML Basics: Introduction to Markup language and HTML, HTML document structure, semantic elements, and content organization. HTML forms and form controls, Basics of Cascading Style Sheets (CSS) including inline, internal, and external styles. Style (CSS), Multiple CSS style sheets, DHTML, Tools for image creation and manipulation, User experience design, IoT development using charts.	8
II	CSS, Dynamic Content, and Web Design Tools Advanced CSS concepts including layouts and responsive design. Use of multiple CSS style sheets and cascading rules. Introduction to Dynamic HTML (DHTML). Tools for image creation and manipulation for web. IoT Development Using Charts. Introduction to IoT data and visualization needs. Types of charts for IoT applications (line, bar, pie, real-time graphs). Integrating IoT data with web dashboards. Introduction to JavaScript, Functions, DOM, Forms, and Event Handlers, Object Handlers, Input validation, J2ME, application design using J2ME.	10
III	JavaScript Application Development Introduction to JavaScript and its role in web development. Basic JavaScript syntax, variables, data types, operators, and control structures. simple JavaScript programs and understanding script execution in web pages. Document Object Model (DOM) and accessing	10

	HTML elements using JavaScript. Handling user events such as clicks, key presses, and form submissions. Object handling in JavaScript. HTML forms using JavaScript.Client-side input validation techniques for text fields, numbers,email, and passwords. Error handling and feedback.Mobile app development: Android Development environment, Simple UI Layouts and layout properties, GUI objects, Event Driven Programming, opening and closing a Database.	
IV	IIoT Fundamentals and Components, Industrial Manufacturing, Monitoring, Control, Optimization and Autonomy, Introduction to Hadoop and big data analytics	8
V	IoT applications Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides. Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, Data Lake services scenarios. Architecture of IoT for Healthcare Applications.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162K	Chemical and Environmental Sensor	PEC	3	0	0	3	2026

1) Course Objectives

The goal of this course is to extend engineering principles to electrochemical sensor development with a clear understanding of oxidation and reduction of an electrolytic cell, propound the conception of ion selective and enzyme stabilized electrodes for the detection of chemical and biomolecules. It also provides expedient in applying specific interaction methods in the recognition of ion selective gases using metal oxide based sensors and to analyze the modes of vibration and develop the suitable mass and thermal sensitive sensors.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Analyze the potential developed in any electrochemical cell.	Analyze
CO 2	Explain chemical sensing methods and material characteristics to be applied in biosensors.	Understand
CO 3	Design gas sensors for commercial and industrial applications.	Apply
CO 4	Build knowledge of nanomaterials for biological and medical applications.	Apply
CO 5	Develop site specific antigen-antibody sensors design for most common diseases like metabolic disorders.	Apply
CO 6	Evaluate process design criteria for gas treatment and air quality analysis.	Apply

3) Syllabus

Electrochemistry-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.

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

Chemical Sensing Elements- 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 the performance of sensors.

Potentiometric and Amperometric Sensors-Potentiometric- Ion selective electrodes- pH linked, Ammonia linked, CO2 linked, Silversulfide 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.Optical Biosensor and Immunosensor Biosensor-Fibre optic biosensor, Fluorophore and chromophore based biosensor, Bioluminescence and chemiluminescence based biosensors, Non labelled and labelled immune sensors, Microbial Biosensors: electrochemical, photo microbial , microbial thermistor, Application of microbial biosensors in glucose, ammonia, acetic acid, alcohol, BOD, methane sensing. Sensors in exhaust gas treatment-Engine combustion process, Catalytic exhaust after treatment, Emission limits, Exhaust sensors and Engine control, Emission test cycles, On-board diagnose (OBD): Diagnose Strategies, Exhaust sensors for OBD, Control Sensors: Hydro-Carbon Sensors, NOx- Sensors, Temperature Sensors, Oxygen Sensors.

Measurement techniques for air quality - 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.

4) References:

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

5) Course Plan

Module	Contents	No. of hours

I	Electrochemistry-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. Transduction Elements- Electrochemical Transducers-Introduction Potentiometry and Ion-Selective Electrodes: The Nernst Equation Voltametry and amperometry, conductivity, FET, Modified Electrodes, Thin-Film Electrodes and Screen-Printed electrodes, photometric sensors.	9
II	Chemical Sensing Elements- 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 the performance of sensors. Potentiometric and Amperometric Sensors- 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.	9
III	Optical Biosensor and Immunosensor Biosensor - Fiber optic biosensor, Fluorophore and chromophore-based biosensor, Bioluminescence and chemiluminescence based biosensors, Non labelled and labelled immune sensors, Microbial Biosensors: electrochemical, photo microbial, Microbial thermistor. Application of microbial biosensors in glucose, ammonia.	9
IV	Sensors in exhaust gas treatment-Engine combustion process, Catalytic exhaust after treatment, Emission limits, Exhaust sensors and Engine control, Emission test cycles, On-board diagnose (OBD): Diagnose Strategies, Exhaust sensors for OBD, Control Sensors: Hydro-Carbon Sensors, NOx-Sensors, Temperature Sensors, Oxygen Sensors.	9
V	Measurement techniques for air quality - 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.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162L	Nanosensors	PEC	3	0	0	3	2026

1) Course Objectives

To provide an overview of nanosensors and nanodevices for various potential applications.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Interpret the physical effects involved in signal transduction.	Apply
CO 2	Describe the materials used for nanosensors and the related packaging technologies	Understand
CO 3	Analyse the different types of inorganic biosensors and its applications.	Analyse
CO 4	Design nanosensors and bioelectronics sensors.	Apply
CO 5	Design Sensors for aerospace and defence applications	Apply

3) Syllabus

Sensor Characteristics: Active and Passive sensors – Static characteristic - Accuracy, offset and linearity, Dynamic characteristics - First and second order sensors. Physical effects involved in signal transduction - Photoelectric effect, Photo dielectric effect, Photoluminescence effect, Electroluminescence effect, Hall effect, thermoelectric effect, Peizoresistive effect, Piezoelectric effect, Pyroelectric effect. Materials for Nanosensors: Shape and size Dependence of Properties at Nanoscale, Surface Energy of a Solid, Core/Shell- Structured Nanoparticles, Metallic Nanoparticles and Plasmons Optical Properties of Bulk Metals and Metallic Nanoparticles, Quantum Dots, Carbon Nanotubes, Inorganic Nanowires, Nanoporous Materials: Nano Based Inorganic Sensors, One dimensional gas sensors:- gas sensing with nanostructured thin films, absorption on surfaces, metal oxide modifications by additives, surface modifications, nano optical sensors, nano mechanical sensors, plasmon resonance sensors with nano particles, AMR. Organic / Biosensors: Role of protein in nanotechnology, using protein in nanodevices, antibodies in sensing, enzymes in sensing, enzyme nanoparticle hybrid sensors, Motor proteins in sensing, transmembrane sensors Nanosensors based on Nucleotides and DNA, DNA decoders and microarrays, DNA protein conjugate based sensors, Bioelectronic sensors.NanoSensors: Temperature Sensors, Smoke Sensors, Sensors for aerospace and defence: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools

4) References

1. Kourosh Kalantar – Zadeh, Benjamin Fry, “Nanotechnology- Enabled Sensors”, Springer

2. H. Rosemary Taylor, “Data acquisition for sensor systems”, Chapman & Hall, 1997.

3. Jerome Schultz, Milan Mrksich, Sangeeta N. Bhatia, David J. Brady, Antonio J. Ricco, David

4 R. Walt, Charles L. Wilkins, “Biosensing: International Research and Development”, Springer

5. Ramon Pallas-Areny, John G. Webster, “Sensors and signal conditioning” John Wiley & Sons, 2001. 6. Peter Hauptmann and Tim Pownall, Sensors: Principles and

Applications , Prentice Hall, 2003
7. Vinod Kumar Khanna, Nanosensors: Physical, Chemical, and Biological, CRC, 2012

5) Course Plan

Module	Contents	No.of hours
I	Sensor Characteristics: Active and Passive sensors – Static characteristic - Accuracy, offset and linearity, Dynamic characteristics - First and second order sensors. Physical effects involved in signal transduction - Photoelectric effect, Photo dielectric effect, Photoluminescence effect, Electroluminescence effect, Hall effect, Thermoelectric effect, Peizoresistive effect, Piezoelectric effect, Pyroelectric effect.	9
II	Materials for Nanosensors Shape and size Dependence of Properties at Nanoscale, Surface Energy of a Solid, Core/Shell-Structured Nanoparticles, Metallic Nanoparticles and Plasmons Optical Properties of Bulk Metals and Metallic Nanoparticles, Quantum Dots, Carbon Nanotubes, Inorganic Nanowires, Nanoporous Materials	9
III	Nano Based Inorganic Sensors One-dimensional gas sensors: - gas sensing with nanostructured thin films, absorption on surfaces, metal oxide modifications by additives, surface modifications, nanooptical sensors, nano mechanical sensors, plasmon resonance sensors with nano particles, AMR	9
IV	Organic / Biosensors Role of protein in nanotechnology, using protein in nanodevices, antibodies in sensing, enzymes in sensing, enzyme nanoparticle hybrid sensors, Motor proteins in sensing, transmembrane sensors Nanosensors based on Nucleotides and DNA, DNA decoders and microarrays, DNA protein conjugate-based sensors, Bioelectronic sensors.	9
V	Nano Sensors Temperature Sensors, Smoke Sensors, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162M	Deep Learning	PEC	2	0	2	3	2026

1) Course Objectives

The purpose of the course is to introduce the fundamental concepts of deep learning frameworks. The course covers the basic theoretical concepts of deep learning for solving engineering problems and provides a comprehensive foundation to artificial neural networks, neuro-modeling, and their applications. This course will help learners to explore the supervised and unsupervised learning paradigms and shallow/deep neural networks.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Compare shallow neural networks and deep neural networks for supervised and unsupervised learning.	Apply
CO 2	Develop neural networks for classification, regression and clustering.	Apply
CO 3	Build neural networks and learn how to lead successful deep learning projects.	Apply
CO 4	Identify the deep neural network more appropriate for various types of learning tasks in various domains.	Apply
CO 5	Implement deep learning algorithms to solve real world problems.	Apply

3) Syllabus

Introduction to deep learning, difference between conventional neural network and deep neural network, Convolutional Neural Network, Transfer learning, Recurrent neural network, Deep Learning tools and applications.

4) References

1. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning" 2015, MIT Press.
2. Josh Patterson and Adam Gibson, “Deep Learning- A Practitioner’s Approach” O’Reilly Media Inc., 2017, USA.
3. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2011.
4. Bengio, Yoshua. "Learning deep architectures for AI- Foundations and trends in Machine Learning, 2(1)- 2009.
5. Rich E and Knight K, “Artificial Intelligence”, 2011, 2 nd ed., TMH, New Delhi

5) Course Plan

Module	Contents	No. of hours

I	Deep Feed Forward Neural Networks-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.	5
II	Convolutional Neural Networks-Convolution operation- kernel and feature map, sparse connectivity, equi-variance through parameter sharing, pooling function for invariant representation, convolution and pooling as strong prior, convolution with stride, effect of zero padding.	5
III	ConvNet and Transfer learning-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. Transfer learning – fully and partially.	7
IV	Recurrent Neural Networks-Sequence learning with neural nets, unrolling the recurrence, training RNN- Backpropagation through time (BPTT), vanishing gradient problem, Gated recurrent unit (GRU), Long short term memory (LSTM), Bidirectional LSTMs, bidirectional RNNs.	7
V	Deep Learning Tools and Applications-Tools: Keras,Tensor Flow and Deep Learning packages like Numpy, Pandas Applications: Object detection with RCNN, YOLO, SSD, 3D-CNN. Speech recognition with RNN.	6
	Total hours	30

List of experiments:

(MatLab Deep Network Designer toolbox or Python libraries)

Deep Feedforward Neural Networks	1.Implement and Train a Deep Feedforward Network from Scratch. - Build an MLP from scratch using NumPy/MATLAB. - Implement forward propagation and backpropagation. - Train on MNIST or a similar dataset. - Provide training curves and confusion matrix.
Convolutional Neural Networks	2.Implement Convolution and Pooling Layers. - Implement convolution, padding, stride, pooling manually. - Validate against framework outputs. 3.Build and Train a Small CNN for Image Classification. - Train CNN on CIFAR-10 or MNIST. - Use data augmentation and visualize feature maps.
ConvNet and Transfer Learning	4. Recreate/Study a Classic ConvNet (LeNet / AlexNet-small). - Implement architecture and report results. 5. Transfer Learning: Fine-tune a Pretrained Model (AlexNet, VGGNet, etc). - Compare feature extraction vs fine-tuning

	- Compare the model performances.
Recurrent Neural Networks	6. Implement a Vanilla RNN for Sequence Prediction. - Train on time-series or character prediction. - Demonstrate vanishing/exploding gradients. 7. LSTM for Time-Series Forecasting or Text Generation. - Compare single vs stacked LSTMs.
Deep Learning Tools and Applications	8. Object Detection Mini-Project (YOLO/SSD simplified). - Use pretrained model or small retraining. - Provide detection visualizations. 9. Semantic Segmentation / 3D-CNN Demonstration.
Total hours	**30**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162N	Embedded Systems Design	PEC	3	0	0	3	2026

1) Course Objectives

This course introduces the role of different hardware, software, and firmware components involved in the design and development of embedded systems. This course aims to introduce the practical concepts of programming a microcontroller, interfacing of external peripherals to microcontroller and debugging of microcontroller based embedded electronic systems.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Identify the components of embedded systems and various steps in embedded system design process.	Apply
CO 2	Describe the different standard communication protocols used in embedded systems.	Understand
CO 3	Explain the architecture and programming model of ARM Cortex M3 processor.	Understand
CO 4	Develop programs to interface ARM cortex M3 processor with peripherals.	Apply
CO 5	Design an embedded system application using ARM cortex M3 processor.	Apply

3) Syllabus

Introduction to Embedded Systems - Overview of Communication Buses and protocols- Designing Embedded Systems with ARM Cortex M3 Processor- Interfacing ARM Cortex M3 to peripheral devices- Embedded System Industry Case Studies and Applications.

4) References:

1. Joseph Yiu, “The Definitive Guide to the ARM Cortex M3”, Second Edition, Elsevier Inc., 2010.

2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
3. Wayne wolf, Computers as Components: Principles of Embedded Computing System Design,Morgan Kaufmann; 2 ed,2008.
4. Lyla B. Das, , 1/e, Lyla B. Das, Embedded Systems, 2012 Embedded Systems: An Integrated Approach
5. J.R.Gibson, ARM Assembly Language –An Introduction, Lulu Press, 2010

5) Course Plan

Module	Contents	No. of hours
I	Introduction to Embedded Systems: General purpose computers vs Embedded System- Characteristics of embedded systems, Classification of embedded systems, Components of embedded system hardware– Software embedded into the system Embedded system design process – Typical applications Embedded Product Development Life Cycle (EDLC) – Different Phases of EDLC- EDLC Approaches Challenges in Embedded system design	8
II	Overview of Communication Buses and protocols: Serial Bus Communication Protocols, Parallel Bus Protocols, Internet Embedded Systems, Network Protocols, Wireless and Mobile System Protocols.	10
III	Designing Embedded Systems with ARM Cortex M3 Processor: Evolution of ARM architecture, ARM Design Philosophy & RISC Architecture, programming model, Cortex M3 Processor architecture, registers and flags, operation modes, memory map, Nested Vector Interrupt Controller, power management. Developing programs with ARM Cortex microcontrollers - Simulating programs on Keil IDE	10
IV	Interfacing ARM Cortex M3 to peripheral devices: Introduction to external peripherals - Interfacing IO devices– LEDs, Switches, Buzzer, Seven Segment Display, LCD, Keypad (4*4), DC Motor, Stepper Motor.	8
V	Embedded System Industry Case Studies and Applications: Interfacing Sensors -IR sensor, Ultrasonic Sensor, Temperature and Humidity sensor, Soil Moisture Sensor, PIR sensor etc. Consumer applications, Industrial Automation, Biomedical applications, Gaming, IoT etc.	9
	Total hours	45

Atleast three of the following program can be given as assignment.

1. Write a program to interface LEDs and buzzer.
2. Write a program to interface switch.
3. Write a Program to design up counter/down counter using seven segment display.
4. Write a program to display characters on Alphanumeric LCD.
5. Write a program to interface keypad and LCD.
6. Write a program to interface stepper motor.
7. Write a program to identify the presence of a person in a room using a PIR sensor.
8. Write a program to find the distance of an object using ultrasonic sensor.
9. Design a burglar alarm system capable of detecting and warning about the presence of an intruder.
10. Design a weather station using temperature and humidity sensor.
11. Write a program to build I2C communication between two microcontrollers.
12. Write a program to build SPI communication between two microcontrollers.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162O	RF and Microwave Sensors	PEC	3	0	0	3	2026

1) Course Objectives

The objective of this course is

a) To introduce the students with different RF and Microwave sensors,
b) To familiarize antenna design with a good understanding of their parameters and applications.
c) To introduce comprehensive knowledge of wearable antennas.
d) To explore and understand basics of RFID technology

2) Course Outcomes

After the completion of the course the student will be able to:

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

3) Syllabus

Basics of Antenna Theory, Antenna for personal area communication, Radio Channel Characterization and Effect of Wearable Antennas Radar Systems, Applications of Radar, defense factors affecting the performance of RADAR, Radiometers, Microwave power Sensors, Thermocouple Sensors, RFID Sensors and technology.

4) References

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, John Wiley and Sons, New Jersey
3. B. Hoffman - Wellenhof, H.Lichtenegger and J.Collins, "GPS: Theory and Practice ", 5th edition, Springer, New York, 2012.
4. Lillesand & Kiefer, “Remote Sensing and Image Interpretation”, 2011, 6th edition, John Wiley and Sons, New Jersey.

5) Course Plan

Module	Contents	No.of hours
I	Antenna for personal area communication: Microwave Antenna- Introduction, types of antennas, fundamental parameters of antennas, radiation mechanism, Fresnel and Fraunhofer regions. Antenna for communication and Antenna for sensing, radiometer and radar. 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.	10
II	Radar, Applications of Radar: Introduction to RADAR, RADAR range equation, MTI and pulse Doppler RADAR, Tracking RADAR, SAR pulse RADAR, CW RADAR. Automotive, remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of RADAR, RADAR transmitters, Receivers	9
III	Radiometers: Radiative transfer theory, SMMR, Types of radiometers - and Bolometers, Applications in automotive, agriculture, medicine, weather forecasting	9
IV	Microwave power Sensors: 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.	8
V	RFID Sensors: Introduction, Components of RFID systems, hardware and software components, RFID standards, RFID applications	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162P	Microsystems and Hybrid Technology	PEC	3	0	0	3	2026

1) Course Objectives:

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

2) Course Outcomes:

After the completion of the course the student will be able to:

#	Description	Level
CO1	Apply fundamental concepts of MEMS and Microsystems	Apply
CO2	Apply the concepts of various sensors and actuators.	Apply
CO3	Compare the scaling effects in miniaturizing devices.	Apply
CO4	Interpret various micromachining techniques and design, analysis and applications of various MEMS devices micromachining tools and techniques	Apply
CO5	Acquainted with thick film and hybrid technologies for sensor development.	Apply
CO6	Incorporate simulation and micro-fabrication knowledge for developing various MEMS devices.	Analyze

3) Syllabus

Introduction to MEMS, Microsystems, Sensors and Actuators, Materials for Microsystems, Scaling Effects in Microsystems, Micromachining Technologies, MEMS and micro systems applications, Hybrid Technology.

4) References

1. G.K.Ananthasuresh, K J Vinoy, S Gopalakrishnan, KN Bhatt, V K Aatre," Micro and smart systems", 2012, 1st ed., Wiley, New York.
2. Tai-Ran Hsu, “MEMS & Microsystem, Design and Manufacture”, 2017, 1st ed., McGraw Hill India, New Delhi.
3. Mahalick NP, "MEMS", 2017, 1st ed., Tata McGraw Hill, New Delhi
4. Wolfgang Menz, Jürgen Mohr, Oliver Paul, "Microsystem Technology", 2011, 2nd ed., Wiley, New York.
5. Banks H.T. Smith R.C. and Wang Y.Smart, ‘Material Structures – Modeling, Estimation and Control’, 2011, 1st ed., John Wiley & Sons, NewYork.
6. MassoodTabib – Arar, ‘Microactuators – Electrical, Magnetic Thermal, Optical, Mechanical, Chemical and Smart structures’, 2014, 1st ed., Kluwer Academic publishers, New York.

5) Course Plan

Module	Contents	No.of hours
I	MEMS and Microsystems, Miniaturization, Benefits of Microsystems, Typical MEMS and Microsystems products, Evolution of Micro fabrication and Applications. 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.	9
II	Silicon, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric materials, Polymers, Shape Memory Alloys, ferroelectric and rheological materials.	9
III	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.	9
IV	Overview of silicon processes techniques, Photolithography, Ion Implantation, and Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.	9
V	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. 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.	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162Q	Digital VLSI Design	PEC	2	0	2	3	2026

1) Course Objectives

The course enables students to analyze the performance of various VLSI circuits and to design digital VLSI circuits using different logic styles, while gaining hands-on experience with industry-standard tools for the design and evaluation of CMOS-based systems.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level

CO 1	Analyse the performance of CMOS inverter.	Apply
CO 2	Design logic circuits using different logic styles	Apply
CO 3	Design arithmetic circuits such as adders and multipliers	Apply
CO 4	Design memory arrays like RAM, ROM, CAM etc.	Apply
CO 5	Apply power reduction techniques to VLSI Circuits	Apply
CO 6	Apply industry-standard tools to design VLSI circuits.	Apply

3) Syllabus

CMOS Inverter: Static and Dynamic Behavior. Power dissipation, Energy, Energy-Delay

Designing combinational logic gates in CMOS: Static CMOS design, Ratioed logic, PTL logic, Clocked logic, Dynamic CMOS Logic, Dual Rail Logic Networks.

Arithmetic Circuits in CMOS VLSI: Bit Adder Circuits, Ripple Carry Adder, Carry Look Ahead Adders, High-speed adders, Multipliers.

Memory Arrays: Memory classification, ROM, SRAM, DRAM, CAM, Sense Amplifiers.

Low power design: Need for low power design, Circuit techniques to reduce static and dynamic power.

4) References

1. John P. Uyemura, Introduction to VLSI Circuits and Systems, Wiley Student Edition 2006.
2. Jan M Rabaey, Digital Integrated Circuits - A Design Perspective, Pearson Education, 2nd Edition, 2016.
3. Neil H. E. Weste and David Harris, Principles of CMOS VLSI Design, 4th Edition, Pearson, 2010.
4. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis & Design, McGraw-Hill Education, 4th Edition, 2014.
5. Christian Piguet, Low-Power CMOS Circuits - Technology, Logic Design and CAD Tools, CRC Press Taylor & Francis Group, 1st edition, 2006.

5) Course Plan

Module	Contents	No. of hours
I	CMOS Inverter: Static behavior – Switching threshold, Noise Margins. Performance of CMOS Inverter - Dynamic behavior. Power dissipation, Energy, and Energy-Delay.	5
II	Designing combinational logic gates in CMOS: Static CMOS design – Complementary CMOS, Ratioed logic, Pass Transistor Logic (PTL). Clocked CMOS, Dynamic CMOS Logic circuits, Dual Rail Logic Networks – Differential Cascade Voltage Switch Logic.	7
III	Arithmetic Circuits in CMOS VLSI: Bit Adder Circuits, Ripple Carry Adder, Carry Look Ahead Adders, Other high-speed adders. Multipliers - Parallel multiplier, Wallace Tree, and Dadda multiplier.	6

IV	Memory Arrays: Memory classification, Memory Core - Read Only Memories, Read Write Memories – SRAM, DRAM. Content - Addressable or Associative Memories (CAM), Sense Amplifiers.	6
V	Low power design: Need for low power design. Circuit techniques to reduce static and dynamic power: Dual threshold CMOS (DTCMOS), Supply voltage scaling, Dynamic supply scaling (DVS), Variable threshold CMOS (VTCMOS), Clock gating, Power gating, Sleep transistors.	6
	Total hours	**30**

List of experiments

1	Familiarization with the simulation tool Design of CMOS inverter a) Simulation of Transient and DC characteristics b) Calculation of delays c) Analysis of CMOS inverter for different beta ratios	6
2	Layout of CMOS inverter a) Physical verification using Assura b) Technology Library mapping c) DRC and LVS check d) Parasitic Extraction e) Post Layout Simulation	3
3	Design of logic gates a) Simulation of the transient characteristics of a 2-input NAND gate b) Layout of the NAND gate	6
4	Design of combinational circuits a) Analysis of 2x1 MUX using static CMOS logic b) 4x1 MUX using 2x1 MUX	3
5	Design of Arithmetic Circuits a) Transient analysis of a single-bit full adder circuit b) Transient analysis of a 4-bit adder circuit c) Design of an array multiplier	9
6	Design of memory a) DC analysis and simulation of the butterfly curve of a 1-bit 6TSRAM cell	3
	Total hours	**30**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162R	Fiber Optic Sensors	PEC	3	0	0	3	2026

1) Course Objectives

The course introduces the different aspects of fiber optic sensors and its application.

2) Course Outcomes

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Describe the concept of a basic optical fiber technology.	Understand
CO 2	Model fiber grating sensors and Fabry-Perot Interferometer Sensors	Apply
CO 3	Analysis of Polarimetric Sensors.	Analyze
CO 4	Explain passive, active detection schemes and multiplexing techniques.	Understand
CO 5	Develop fiber optic sensors for various applications	Apply

3) Syllabus

Review of optical fibre technology, Introduction to fiber optic sensors, Fiber Bragg grating sensors, Fabry-Perot Interferometer Sensors, Interrogation Techniques Passive and active detection schemes,multiplexing techniques, applications of Fiber Optic Sensors

4) References

1. Shizhuo Yin, Paul B Ruffin, Francis T. S. Yu " Fiber Optic Sensors", CRC Press, Taylor & Francis group, 2nd edition, 2008
2. Wojtek J Bock, Israel Gannot, Stoyan Tanev "Optical waveguide sensing and Imaging, Springer, 2006.

5) Course Plan

Module	Contents	No. of hours
I	Review of optical fiber technology: optical fiber, sources, amplifiers and detectors; Introduction to fiber optic sensors, classification: - based on sensing location, operating principle & applications.	9
II	Fiber Bragg gratings, long period gratings and their applications. Modelling of fiber grating sensors, multi- parameter sensitivity problem. Fabry-Perot Interferometer Sensors: Fabry-Perot Interferometer - theory and sensor configurations. Embedded sensors.	9
III	Polarimetric Sensors Polarization, Jones Matrix calculations, Birefringent Optical fiber, Polarimetric sensors, Temperature sensing, Coherence, Impact detection. Optical current measurement, Optical voltage sensor, Optical network instability diagnosis.	9

IV	Interrogation Techniques Passive detection schemes: - The use of linearly dependent devices, Power detection, CCD spectrometer interrogator. Active detection schemes: Acousto optic tunable filter interrogator, matched fiber Bragg grating pair interrogator. Michelson Interferometer interrogator, Multiplexing techniques	9
V	Applications of Fiber Optic Sensors Applications to large composite and concrete structures- Mines, Dams, Aircraft etc. Applications to electric power industry- load monitoring of power transmission lines, winding temperature measurement, electric current measurement. Applications to medicine- Temperature, ultrasound. Chemical sensing. Applications to oil and gas industry	9
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC162S	Large Scale Data Analytics	PEC	3	0	0	3	2026

1) Course Overview:

This course helps the learner to understand the basic concepts of Large Scale data analytics. This course covers mathematics for data analytics, predictive and descriptive analytics of data, large scale data and its applications, techniques for managing big data and data analysis & visualization using R programming tool. It enables the learners to perform data analysis on a real world scenario using appropriate tools.

2) Course Outcomes:

After the completion of the course the student will be able to

#	Description	Level
CO1	Explain the fundamentals of big data, massive datasets, data mining concepts, and analytics applications.	Understand
CO2	Apply data preprocessing, transformation, and dimensionality reduction techniques to prepare large-scale datasets for analysis.	Apply
CO3	Make us of frequent pattern mining and classification algorithms to evaluate their performance on real-world datasets.	Apply
CO4	Illustrate descriptive statistics, exploratory data analysis, and parametric statistical tests used for data interpretation.	Understand
CO5	Demonstrate the usage of Map Reduce paradigm for Big Data Analytics.	Apply

3) References:

1. Bart Baesens," Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.
2. David Dietrich, "EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, 2015.
3. Jaiwei Han, MichelineKamber, "Data Mining Concepts and Techniques'', Elsevier,

2006.
4. Christian Heumann and Michael Schomaker, “Introduction to Statistics and DataAnalysis”, Springer, 2016

4) Course Plan:

Module	Contents	No. of hours
I	**Introduction to Big Data and Data Mining** Introduction to big data and massive datasets. Characteristics of big data. Types of data: structured, semi-structured, unstructured. Data mining concepts and functionalities. Data mining tasks: classification, clustering, association, prediction. Challenges in mining massive datasets. Overview of analytics applications.	8
II	**Data Preprocessing and Dimensionality Reduction** Data cleaning and data integration. Data transformation and normalization. Data reduction techniques. Feature selection and feature extraction. Dimensionality reduction techniques. Principal Component Analysis (PCA). Sampling techniques for large datasets.	9
III	**Frequent Pattern Mining and Classification** Frequent itemset mining concepts. Apriori algorithm FP-Growth algorithm. Association rule generation and evaluation. Classification methods: decision trees, Naive Bayes classification. Rule-based classification. Model evaluation and accuracy measures.	10
IV	**Basic concepts of analytics:** definition, data–information–knowledge hierarchy, types of analytics (descriptive, diagnostic, predictive, prescriptive), and analytics workflow, Descriptive statistics, Exploratory Data Analysis (EDA)Data exploration versus data presentation. Statistical methods for evaluation and interpretation: Parametric test.	9
V	**Introduction to Hadoop ecosystem**. Hadoop architecture. HDFS design and components. MapReduce programming model. Developing and executing MapReduce programs. Case studies using Hadoop for large-scale analytics.	10
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
26EC166A	Automotive Electronics	IEC	2	1	0	3	2026

1) Course Objectives:

The course aims to impart the knowledge of state-of-the-art automotive electronics and real-world applications.

2) Course Outcomes:

After the completion of the course the student will be able to:

#	Description	Level
CO 1	Explain the fundamentals of automobile dynamics and electronic systems	Understand
CO 2	Design interfacing circuits for automotive sensors and actuators	Apply
CO 3	Explain energy generation, storage, various electronic circuits and systems in vehicles.	Understand
CO 4	Design automotive instrumentation, lighting and motor systems.	Apply
CO 5	Explain road wheel control systems, buses and automotive software development.	Understand

3) Syllabus

Automotive Fundamentals Overview-Evolution of Automotive Electronics, Ignition System- Diesel Engine, , Starter Battery -Operating principle.The Basics of Electronic Engine Control- Definition of General terms, Automotive Sensors, Automotive actuators, Electronic control unit (ECU), Batteries, Vehicle circuits and systems, Generation of electric energy, Starting motor systems, Vehicle lighting systems, Instrumentation, Road wheel control system, Automotive Networking, Buses, Automotive Software development.

4) References

1. VAW Hillier, Hilier's Fundamentals of Automotive Electronics, 6th Edition, Oxford University Press, 2014
2. Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley & Sons Inc., 2007.
3. Najamuz Zaman, "Automotive Electronics Design Fundamentals''first edition, Springer 2015.
4. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals",CRC Press, 3rd Edition, 2021.

5) Course Plan

Module	Contents	No. of hours

I	Automotive Fundamentals Overview-Evolution of Automotive Electronics, The Engine - Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System- Diesel Engine, Starter Battery - Operating principle. The Basics of Electronic Engine Control- Definition of General terms, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition	9
II	Automotive Sensors -type of sensors, pressure sensor, position and level sensor, flow sensors, temperature sensor, gas sensors, knock sensors. Automotive actuators - Linear solenoids, linear motors, Rotary actuators, stepper motors. Electronic control unit (ECU) - microprocessors, computers.	9
III	Batteries - battery types, small batteries, Battery pack management - battery management system (BMS), SoC measurements. Battery cell balancing, battery charging and maintenance. Vehicle circuits and systems - Electrical circuits, cables, terminals and connectors, circuit protection, remote switching and multiplexing, fault diagnosis. Generation of electric energy - Charging circuit principles, the alternator.	9
IV	Starting motor systems- types of light vehicle motors, circuits for light vehicle motors, Light vehicle starting motor drive mechanisms, Heavy vehicle motors, maintenance and fault diagnosis. Vehicle lighting systems - circuit layout, lamp construction, maintenance and fault diagnosis. Instrumentation - Electronic condition monitoring, electronic displays, windscreen wipers, washers, ORVM, climate control, Direction indicators, Engine cooling fan.door locking and vehicle security.	9
V	Road wheel control system - Cruise control, Anti-lock braking system(ABS), Automatic transmission control, Traction control. Automotive Networking -Bus Systems- Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles Buses - CAN Bus, UN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces. Automotive Software development - Automotive SPICE, V lifecycle, Scrum process, Software verification, Unit testing, SW Integration testing, SW Qualification testing , HILS testing	9
	Total hours	**45**