CURRICULUM

B. TECH IN ELECTRONICS AND INSTRUMENTATION ENGINEERING DEPARTMENT
NIT SILCHAR

Program Educational Objectives (PEOs):

The PEOs of the B. Tech in Electronics & Instrumentation Engineering program are

1. Deliver comprehensive education in Electronics and Instrumentation Engineering to ensure that the graduates have the core competency to be successful in industry or excel in higher studies in any of the following fields: Industrial Process engineering, Microelectronics and VLSI Design, Signal Processing, Communication Engg., Automation and Control, and Biomedical Instrumentation.
2. Provide students foundation in mathematical and engineering fundamentals required to solve engineering design problems and also to pursue research.
3. Train students to work as teams to comprehend, analyze, design, and create innovative solutions to real life problems.
4. Inculcate a sense of ethics, professionalism, and effective communication skills amongst graduates.
5. Provide an academic environment that gives adequate opportunity to the students to cultivate lifelong skills needed for a successful professional career.

Program Specific Outcomes (PSOs):

The students of Electronics and Instrumentation Engineering (EIE) will be able to:

PSO1: Apply the fundamentals of mathematics, science and engineering knowledge to identify, simulate, design, develop and investigate complex problems of electronic circuits, measurement, instrumentation, biomedical, signal processing and industrial process control fields.

PSO2: Apply appropriate techniques with suitable hardware and/or software tools to measure, analyse, design, develop and control electronic and instrumentation systems to engage in life-long learning and work efficiently as an individual and in a multidisciplinary team.

PSO3: Understand the impact of professional behaviour and ethics and effective communication with engineering community and the society.

Program Objectives (POs):

1. Graduates will be able to apply knowledge of basic sciences and engineering in the solution of electronics and instrumentation engineering problems.
2. Graduates will demonstrate an ability to identify, formulate, analyze and solve electronics and instrumentation engineering problems.
3. Graduates will demonstrate an ability to design electronic circuits, conduct experiments, analyze and interpret the resulting data.

4. Graduates will demonstrate an ability to design a system, component or algorithms to meet desired needs within the context of electronics and communication engineering and considering realistic constraints.
5. Graduates will demonstrate an ability to visualize and work on multi-disciplinary laboratories.
6. Graduates should be able to design optimal systems / processes using their core technical skills, considering economic, environmental, social, ethical, health, safety and sustainability constraints.
7. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
8. Graduates will have an understanding of professional and ethical responsibilities
9. Graduates will have effective communication skills.
10. Graduate will show the understanding of impact of engineering solutions on the society, environment and awareness of contemporary issues.
11. Graduates will develop confidence for self-education and ability for life-long learning.
12. Graduates will be competent to participate and succeed in competitive examinations.

COURSE STRUCTURE
B. Tech. (4 Year, 8 Semester Course) in Electronics and Instrumentation Engineering, NIT Silchar

Effective from academic Year 2018

Semester I						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	PH 101	Physics	3	1	0	4
2	MA 101	Mathematics I	3	1	0	4
3	ME 101	Engineering Mechanics	3	1	0	4
4	EE 101	Basic Electrical Engineering	3	1	0	4
5	HS 101	Communicative English	3	0	0	3
6	PH 111	Physics Laboratory	0	0	3	2
7	CE 101	Engineering Graphics Design	1	0	3	3
8	EE 111	Basic Electrical Engineering Laboratory	0	0	3	2
9	HS 111	Language Laboratory	0	0	3	2
10		Extra-Academic Activities (EAA)[1]	0	0	2	0
Total Credit						28

Semester II						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	CH 101	Chemistry	3	1	0	4
2	MA 102	Mathematics II	3	1	0	4
3	CS 101	Introduction to Programming	3	1	0	4
4	EC 101	Basic Electronics	3	1	0	4
5	CE 102	Environmental Science & Engineering	3	0	0	3
6	CH 111	Chemistry Laboratory	0	0	3	2
7	CS 111	Programming Laboratory	0	0	3	2
8	EC 111	Basic Electronics Laboratory	0	0	3	2
9	ME 111	Workshop Practice	0	0	3	2
10		Extra-Academic Activities (EAA)[1]	0	0	2	0
Total Credit						27

1 EAA consists of YOGA/Physical Training/NCC/NSS/NSO, where YOGA is compulsory as a one semester course (first or second semesters), while any one from the rest is compulsory as a one semester course. Thus, if YOGA is registered in first semester then any one from the rest four is to be opted in second semester and vice-versa.

Semester III						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 201	Electrical & Electronic Measurements	3	1	0	4
2	MA 201	Mathematics III	3	1	0	4
3	EI 202	Analog Electronics	3	1	0	4
4	EI 203	Circuits & Networks	3	1	0	4
5	CS 222	Data Structure & Algorithm	3	1	0	4
6	EI 211	Measurement Lab	0	0	3	2
7	EI 212	Analog Electronics Lab	0	0	3	2
8	EI 213	Circuits & Networks Lab	0	0	3	2
9	CS 223	Data Structure and Algorithm Lab	0	0	3	2
Total Credit						28

Semester IV						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 204	Sensors and Transducers	3	1	0	4
2	EI 205	Signals and Systems	3	1	0	4
3	EI 206	Control System-I	3	1	0	4
4	EI 207	Digital Electronics	3	1	0	4
5	EI 208	Power Electronics & Drives	3	0	0	3
6	EI 214	Sensor and Transducers Lab	0	0	3	2
7	EI 215	Control System Lab	0	0	3	2
8	EI 216	Digital Electronics Lab	0	0	3	2
9	EI 217	Power Electronics Lab	0	0	3	2
Total Credit						27

Semester V						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 301	Industrial Instrumentation-I	3	1	0	4
2	EI 302	Microprocessors & Micro Controllers	3	1	0	4
3	EI 303	Biomedical Instrumentation	3	0	0	3
4	EI 304	Control System-II	3	1	0	4
5	EI 305	Communication & Telemetry	3	1	0	4
6	EI 311	Microprocessors & Micro Controllers Lab	0	0	3	2

7	EI 312	Biomedical Instrumentation Lab	0	0	3	2
8	EI 313	Communication & Telemetry Lab	0	0	3	2
9	EI 314	Virtual Instrumentation Lab	1	0	3	3
Total Credit						28

Semester VI						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 306	Industrial Instrumentation-II	3	1	0	4
2	EI 307	Process Control Engineering	3	1	0	4
3	EI 308	Digital Signal Processing	3	1	0	4
4	EI 3XX	Professional Core Elective I	3	1	0	4
5	EI 3XX	Open Elective-I	3	0	0	3
6	EI 315	Instrumentation Lab	0	0	3	2
7	EI 316	Industrial Process Control and Automation Lab	0	0	3	2
8	EI 317	Digital Signal Processing Lab	0	0	3	2
9	EI 318	Simulation, Design & Fabrication Lab	0	0	3	2
Total Credit						27

Semester VII						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 401	Analytical & Optical Instrumentation	3	0	0	3
2	EI 4XX	Professional Core Elective II	3	1	0	4
3	EI 4XX	Open Elective II	3	0	0	3
4	HS 401	Managerial Economics	3	0	0	3
5	EI 497	Industrial Training (Minimum 6 weeks)				2
6	EI 498	Project I	0	0	6	4
Total Credit						19

Semester VIII						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	MS 401	Business Management	3	0	0	3
2	EI 4XX	Professional Core Elective III	3	1	0	4
3	EI 4XX	Open Elective III	3	0	0	3
4	EI 499	Project II	0	0	9	6
Total Credit						16

Elective Courses

Professional Core Elective I Semester VI						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 331	IC and VLSI Design	3	1	0	4
2	EI 332	Power Plant Instrumentation	3	1	0	4
3	EI 333	Computer Networks	3	1	0	4
4	EI 334	PC Based Instrumentation	3	1	0	4
5	EI 335	Electro-Magnetic Field Theory	3	1	0	4
6	EI 336	Smart Sensors	3	1	0	4
7	EI 337	Optimization Techniques	3	1	0	4

Open Elective I Semester VI						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 381	Air Pollution and Environmental Instrumentation	3	0	0	3
2	EI 382	Opto-Electronics and Fibre Optics	3	0	0	3
3	EI 383	Digital Image Processing	3	0	0	3
4	EI 384	Wind and Solar Based System	3	0	0	3
5	EI 385	Soft Computing Techniques and Applications	3	0	0	3
6	EI 386	Wireless Sensor Networks	3	0	0	3
7	EI 387	Logic and Distributed Control System	3	0	0	3
8	EI 388	Aerospace and Navigation Instrumentation	3	0	0	3

Professional Core Elective II Semester VII						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 431	Advanced Instrumentation	3	1	0	4
2	EI 432	Biomedical Signal processing	3	1	0	4
3	EI 433	Real Time Embedded Systems	3	1	0	4
4	EI 434	IoT based Instrumentation	3	1	0	4
5	EI 435	MEMS & Nanotechnology	3	1	0	4
6	EI 436	Non Linear Control Systems	3	1	0	4
7	EI 437	Linear Integrated Circuits	3	1	0	4

Open Elective II Semester VII						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 481	Robotics and Automation	3	0	0	3
2	EI 482	Instrumentation in Petrochemical Industry	3	0	0	3
3	EI 483	Neural Networks and Fuzzy logic	3	0	0	3
4	EI 484	Renewable Energy Systems	3	0	0	3
5	EI 485	Machine Learning	3	0	0	3
6	EI 486	Probability and Random Processes	3	0	0	3
7	EI 487	Human Computer Interfaces	3	0	0	3
8	EI 488	Mobile Adhoc and Sensor Networks	3	0	0	3
9	EI 489	Aquaponics Monitoring and Control	3	0	0	3

Professional Core Elective III Semester VIII						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 441	Advanced Sensors and Signal Processing	3	1	0	4
2	EI 442	Piping and Instrumentation	3	1	0	4
3	EI 443	Industrial Automation	3	1	0	4
4	EI 444	Wireless Communication	3	1	0	4
5	EI 445	Adaptive Control	3	1	0	4
6	EI 446	Analog Integrated Circuit Design	3	1	0	4
7	EI 447	Mechatronics	3	1	0	4

Open Elective III Semester VIII						
Sl. No.	**Code**	**Course Name**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	EI 490	Intelligent Instrumentation	3	0	0	3
2	EI 491	Advanced Process Control	3	0	0	3
3	EI 492	Bio-signal Processing	3	0	0	3
4	EI 493	Advanced Memory Technology	3	0	0	3
5	EI 494	Introduction to Cyber Physical systems	3	0	0	3
6	EI 495	Optimization Methods in Engineering	3	0	0	3
	EI496A	Information Theory, Cryptography & Security	3	0	0	3
7	EI 496B	Modelling and Control of Energy Storage Systems	3	0	0	3

SYLLABUS

EI 201 | **Electrical & Electronic Measurements**
B. Tech (Electronics & Instrumentation Engg.)
Third Semester (Core)

L	T	P	C
3	1	0	4

Unit-1 **Measurement and error:** Introduction, Definition, significance of measurement, Measurement characteristics, Calibration of instruments, Static & dynamic characteristics. SI UNITs, Types of errors, Systematic and Random Errors in Measurements, expression of uncertainty-accuracy and precision index, propagation of errors, Probability of errors, Statistical analysis and Limiting error with examples.

Unit-2 **Electrical Measuring instruments**: Classification of instruments, Principle and working of PMMC, Moving iron, Dynamo Meter type instruments, Overview of Ammeter, Voltmeter & Multimeter, True rms meters, Voltage and current Scaling, Galvanometer, different types of galvanometer and their applications, DC Potentiometers, AC potentiometers. Extension of range of instruments**-** shunts & multipliers**-** Instrument Transformers, Current transformers- Potential Transformers.

Unit-3 **A. C And D. C Bridges:** General equation for bridge balance, Bridges for measurement of R, L and C, D.C. bridges, Wheatstone bridge, Kelvin's double bridge, General form of an A.C. bridge, Maxwell's inductance – capacitance bridge, Hay's bridge, Anderson's bridge, Schering bridge, Wien's bridge, Sources of errors in bridge measurement, Shielding and Grounding, Wagner earthing device.

Unit-4 **Measurement of power and energy:** Definitions of power, types, Measurement of power, different methods, construction and working of Electrodynamometer type of Wattmeter. Errors in power measurements. Energy, Induction type energy meter, Indicating type Frequency meter, Electrodynamometer type P.F. meter- construction and working principle, advantages, disadvantages. Measurement of Voltage, Current and Power in three-phase and single phase circuits.

Unit-5	**Electronic measuring Instruments:** Measurement of quality factor (Q), Q-meter, Digital Voltmeter (DVM)-Ramp type, Integrating type, ADC, Digital frequency meter, Timer/Counter, AC and DC current probes, CRO probes, Oscilloscopes-CRO, Construction, Time based circuit, Measurement of time, phase and frequency, with CRO, Basics of DSO and applications.
Unit-6	**Signal generations and waveform analysing instruments:** Function generator-Square, triangular Sinusoidal waveform generator, Spectrum analyser.

Text Books:

1. Sawhney Ashok K. ***A course in Electrical and Electronic Measurements and Instrumentation***. Dhanpat Rai & Co, New Delhi (2015).
2. Helfrick Albert D. and Cooper William D. ***Modern Electronic Instrumentation and Measurement Techniques.*** Prentice Hall India Learning Private Limited, London (2013).

Reference Books:

1. Gupta Jitendra B. ***Electronics Measurement & Instrumentation***. Katson Books (2013).
2. Kalsi Hari S.. ***Electronic Instrumentation.*** Tata McGraw Hill, New Madan Gopal. ***Control Systems Principles and Design.*** Tata McGrow Hill**,** New Delhi (2010).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the significance of measurement and types of errors in measurement.
2. Choose the appropriate instruments to measure a given set of parameters.
3. Develop an ability to use AC and DC bridges for measurements.
4. Relate the usage various measurement standards.
5. Analyze the concepts of sinusoidal, triangular and square waveforms.

MA 201	**Mathematics-III**	**L T P C**
	B. Tech (All Branches) Third Semester	**3 1 0 4**

Unit-1	**Partial Differential Equation:** Formation of partial differential equations (PDE), Solution of PDE by direct integration, Lagrange's linear equation, Non-linear PDE of first order, Charpit's Method, Homogeneous and Non-homogeneous linear equations with constant coefficients, Boundary and initial value problems (Dirichlet and Neumann type): Heat, Wave & Laplace's equations (Two dimensional Polar & Cartesian Co-ordinates), Solution by the method of separation of variables.
Unit-2	**Fourier Transforms:** Introduction to Fourier series, Fourier sine and cosine transforms, Solution of PDE by Fourier transform.
Unit-3	**Probability & Statistics:** Introduction to probability, Additive & multiplicative

Laws of probability, Conditional probability, Independent events, Baye's theorem, Random variable, Probability mass function, Probability density function, Cumulative distribution function, Binomial, Poisson & Normal distributions.
Curve fitting: Fitting of straight lines & parabolas by the method of least squares.

Correlation & Regression analysis: Coefficient of correlation, Coefficient of regression, Lines of regression.

Text Books:

1. Seymour Lipschutz and John J. Schiller. ***Introduction to Probability and Statistics.*** Schaum's Outline Series**,** New York **(**2011**)**.
2. Erwin Kreyszig. ***Advanced Engineering Mathematics.*** 10th Edition, Wiley India Pvt. Ltd., New Delhi **(**2015**)**.
3. Ian N. Sneddon***. Elements of Partial Differential Equations.*** McGraw-Hill, New York(1988).

Reference Books:

1. Joghee Ravichandran. ***Probability and Statistics for Engineers.*** Wiley India Pvt. Ltd., New Delhi**(**2010**)**.
2. B.S. Grewal. ***Higher Engineering Mathematics.*** Khanna Publisher, New Delhi(2017).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Be capable of solving partial differential equations arising in engineering problems.
2. Be capable to apply Fourier series and transforms in engineering and daily life problems.
3. Apply basic idea of probability and statistics in engineering problems.

EI 202	**Analog Electronics**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Third Semester (Core)**	**3 1 0 4**

Unit-1 **Introduction**: Characteristics and applications of diode, Zener diode, Basics of operational amplifiers, Characteristics of an ideal operational amplifier and its block diagram, Definition of differential voltage gain, CMMR, PSRR, slew rate and input offset current, Frequency Response, Application of operational amplifiers- first and second order filters, Difference amplifier, Adder, Subtractor, Integrator, Differentiator, Comparator, Clipper, clamper, Schmitt Trigger, Instrumentation Amplifier, Logarithmic amplifiers rectifiers, Precision rectifier.

Unit-2 **Transistor Amplifiers:** Small Signal BJT amplifiers, AC equivalent circuit, hybrid model and their use in amplifier design. Analysis of single stage transistor amplifier using h-parameters: voltage gain, current gain, Input impedance and Output impedance. Comparison of transistor configurations. Differential and multistage amplifiers

Unit-3 **JFET and MOSFET:** JFET operation and characteristics, Biasing and small signal model of JFET, MOSFET symbols and characteristics (Enhancement and depletion mode), Small signal operation and models of MOSFET, Nonlinear one-port and two-port circuits, large signal and small signal analysis of MOSFET, nMOS and pMOS transistor. Internal capacitance of MOSFET: Gate capacitive effect and junction capacitance, Single stage MOS amplifiers, Comparison of Transistors

Unit-4 **Introduction to Active Filters:** First and second order Low-Pass Butterworth filter; filter Design, Frequency Scaling, First and Second-Order High-Pass Butterworth filters, Band-Pass and Band-Stop Filters; Wide Band-Pass, Band-reject and Narrow Band-Pass, Band Reject filters, All-Pass Filters.

Unit-5 Feedback topologies and analysis for discrete transistor amplifiers; stability of feedback circuits using Barkhausen criteria, Oscillators; Oscillator Principles, Oscillator Types, Frequency Stability, Phase shift oscillator, Wien Bridge Oscillator, Quadrature Oscillator, Square-Wave generator, Triangular-wave Generator, Saw tooth-wave generator, Voltage controlled Oscillator, timer 555, Multivibrators and Phase locked loop.

Text Books:

1. Boylestad Robert L. and Nashelsky Louis. ***Electronic Devices and Circuits theory***. Pearson Education, New Delhi (2009).
2. Sedra Adel S. and Smith Kenneth C. ***Microelectronic Circuits Theory and Application.*** Oxford University Press, New Delhi (2017).
3. Cathey Jimmie J. and Singh Ajay K. ***Electronic Devices and Circuits.*** Tata McGraw Hill Publishing Company Ltd., New Delhi (2006).

Reference Books:

1. Neamen Donald A. ***Electronics Circuits Analysis and Design.*** Tata McGraw Hill Publishing Company Ltd., New Delhi (2006).
2. Millman Jacob, Halkias Christos C. and Jit Satyabrata. ***Milliman's Electronics Devices and Circuits***. Tata McGraw Hill Publishing Company Ltd., New Delhi (2015).
3. Millman Jacob and Halkias Christos C. ***Integrated Electronics: Analog and Digital Circuits and Systems.*** Tata McGraw Hill Publishing Company Ltd., New Delhi (2015).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain fundamental terminologies and concepts of amplifiers, filters and oscillators.
2. Perform the analysis of any analog electronics circuit consisting BJT, FET and OP-AMP.
3. Design amplifier circuits using BJT, FET & OPAMP and observe the amplitude & frequency responses.
4. Analyze feedback topologies, active filters, BJT/FET/Operational Amplifiers

EI 203	**Circuits and Networks**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Third Semester (Core)**	**3 1 0 4**

Unit-1	**Basic circuit concepts:** Lumped circuits, circuits elements, Voltage and current sources: independent, dependent, ideal and practical. V-I relationships of R, L and C, mutual inductor, simple resistive circuits, Kirchhoff's Laws, analysis of series and parallel circuits, network reduction, voltage division, current division, source transformation, star-delta transformation.
Unit-2	**Sinusoidal Steady State Analysis:** Concepts of phasor and complex impedance and admittance, analysis of simple series and parallel circuits, Peak, average and rms values of ac quantities: apparent power, active power, reactive power and power factor, series resonance and parallel resonance, bandwidth and Q factor, solution of three phase balanced circuits, power measurements by two wattmeter methods, solution of three phase unbalanced circuits.
Unit-3	**Circuits And Theorems:** Analysis of complex circuits using mesh and nodal methods, superposition theorem, Thevenin's theorem, Norton's theorem, reciprocity theorem, compensation theorem, substitution theorem, maximum power transfer theorem, Millman's theorem with applications.
Unit-4	**Response of electric circuits**: Concept of complex frequency, pole-zero plots, frequency response of RL, RC and RLC circuits, transient response of RL, RC and RLC series and parallel circuits with dc excitation, free response, step and sinusoidal responses, natural frequency, damped frequency, damping factor and logarithmic decrement, response of circuits for non-sinusoidal periodic inputs, locus diagrams.
Unit-5	**One and two-port network and filters:** Driving point and transfer impedances, admittances, voltage and current ratios of one and two-port networks, admittance, impedance, hybrid – transmission and image parameters for one and two-port networks, impedance matching, equivalent Π and T networks, passive filters as a one and two-port network, realization of basic filters with R, L and C elements, characteristics of ideal filter, low pass and high pass filters, open- and short- circuit parameters.

Text Books:

1. Valkenburg Mac Elwyn Van. ***Network Analysis.*** Pearson Education India, New Delhi (2015).
2. Kuo Franklin F. ***Network Analysis & Synthesis***. Wiley, New York (2006).

Reference Books:

1. Alexander Charles K. and Sadiku Matthew N. O. ***Fundamentals of Electrical Networks***. Tata McGraw Hill Education, New Delhi (2019).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Solve any DC and AC circuit theorems.
2. Analyze steady state response of electric circuits.
3. Apply Laplace Transform to find transient responses of circuits.
4. Analyze frequency response of circuits, filter circuits analysis.

5. Analyze two-port networks and Synthesize networks.

CS 222	Data Structure & Algorithm	L	T	P	C
	B. Tech (ECE & EIE) Third Semester (Core)	3	1	0	4

Unit-1 **Introduction**: Introduction to data types, Data structures and Abstract Data Types (ADT), asymptotic notations; algorithms as a technology, designing algorithms, complexity analysis of algorithms.

Unit-2 **Lists**: Linked list, doubly linked list: header list, polynomial arithmetic, stack, recursion and their implementation; evaluation of postfix expression, conversion from infix to postfix expression and their algorithms; queue, circular queue; priority queues; Dequeue; multiple stacks and queues

Unit-3 **Trees**: Introduction, Binary tree, BST, AVL trees, B Trees, B+ Trees; Multiway Search trees: Implementation of dictionary and binary search tree; heap; hashing and hash table.

Unit-4 **Graphs**: Basic concepts; Representation schemes; graph traversals; spanning tree; shortest path algorithm.

Unit-5 **Sorting & Searching**: Different sorting techniques; Tree searching and graph searching techniques.

Books:

1. Tanenbaum A.S., Langsam Y., Augenstein M. J. , *Data Structures using C/C++*, PHI
2. Aho V., Ullman J.D., *Data Structure Addision*, Wesley
3. Knuth D.E , *The Art of Computer Programming (Vol. 1, 2, 3)* , Addision- Wesley
4. Horowitz E., Sahni S. , *Fundamentals of Data Structures,* Galgotia Pub.
5. Wirth N , *Algorithms, Data Structures, Programs* . PHI

Course Outcomes (COs):
At the end of the course, students are expected to

1. be able to select appropriate data structure to be used for specified problem definition.
2. be able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
3. be able to implement projects requiring the implementation of the learned data structures.
4. be able to analyze running time of algorithms

EI 211	Measurement Lab	L	T	P	C
	B. Tech (Electronics & Instrumentation Engg.) Third Semester Core)	0	0	3	2

List of Experiments:

1. Measurement of an unknown medium resistance using Wheatstone bridge.

2. Measurement of an unknown low resistance using Kelvin's double bridge.
3. Measurement of an unknown self-inductance using Maxwell's inductance capacitance bridge.
4. Determination of critical damping resistance of a D'Arsonval galvanometer
5. Calibration of Ammeter, Voltmeter and Wattmeter using Potentiometer.
6. a) Design, construction and calibration of series and shunt type Ohmmeters;
   b) Measurement of insulation resistance of cable by Megger or Insulation tester
7. Calibration of wattmeter at different Power Factors.
8. Testing of CT & PT; Measurement of power of HV circuit using CT & PT.
9. Measurement of unknown Parameter using LCR meter (Q-meter).
10. Measurement of unknown Frequency using Frequency Counter Trainer.
11. Measurement of three-phase power by two wattmeter method.
12. Measurement of Phase & Frequency with CRO.
13. Magnetic measurement using Ballistic Galvanometer.
14. Measurement of R, L and C by using RLC bridge instrument.
15. Measurement of resistance by using: (i) Wheatstone bridge, (ii) Kelvin's double bridge.
16. Study of various types of multimeters and measurement of different AC, DC parameters.
17. Demonstration of MC, MI, Induction type and dynamometer type instruments.
18. Measurement of self-inductance, mutual inductance and coupling coefficient of transformer windings & Air cored Coils
19. Extension of range of Ammeter, Voltmeter and Wattmeter using Shunt Series resistance and instrumentation Transformers.
20. Calibration of Single Phase energy meter by: (i) Direct Loading; (ii) Phantom Loading at various points
21. Calibration of 3 Phase energy meter using standard watt meter.
22. a)Measurement of Capacitance using Schering Bridge; b) Measurement of Frequency using Wien's bridge

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Understand the working of Ammeter, Voltmeter, Wattmeter, Ballistic Galvanometer, Q-meter, CRO, CT, PT, Energy meters and multimeters.
2. Analyze and to measure R, L and C using various bridges.
3. Analyze and measure the frequency, phase, mutual inductance, coupling coefficient of transformer, power and AC/DC parameters for various circuits.
4. Understand the methodology for range extension of ammeter, voltmeter and wattmeter.
5. Apply concepts of electrical measurement for practical implementations in engineering applications.

EI 212	**Analog Electronics Lab**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Third Semester (Core)**	**0 0 3 2**

List of Experiments:

1. Study of Instrumentation amplifier.
2. To implement the Operational Amplifier as a) Comparator, b) Summer and c)

Subtractor.
3. To implement the Operational Amplifier as a Schmitt Trigger.
4. To study the Monostable multivibrator using IC 555 timer.
5. To study the astable multivibrator using IC 555 timer.
6. To implement a voltage regulatory circuit using Zener Diode.
7. To study the Biasing Techniques.
8. Design of bistable multivibrators, design of Schmitt trigger.
9. Design of Wein bridge oscillator using BJT.
10. Design of RC phase shift oscillators using BJT/ FET.
11. Design of Collpitt"s oscillators using BJT, Design of Hartly oscillators using BJT.
12. Study of Frequency response of Common Source (CS) amplifier.
13. To study different VI using NI Basic Electronics modules.
14. Active Filter Applications – LPF, HPF (first order).
15. IC 565 – PLL Applications, IC 566 – VCO Applications.
16. 4 bit DAC using OP AMP.
17. To study different VI using NI Basic Electronics modules.
18. Study of Instrumentation amplifier.
19. To implement the Operational Amplifier as a) Comparator, b) Summer and c) Subtractor.
20. To implement the Operational Amplifier as a Schmitt Trigger.
21. To study the Monostable multivibrator using IC 555 timer.
22. To study the astable multivibrator using IC 555 timer.
23. To implement a voltage regulatory circuit using Zener Diode.
24. To study the Biasing Techniques.
25. Design of bistable multivibrators, design of Schmitt trigger.
26. Design of Wein bridge oscillator using BJT.
27. Design of RC phase shift oscillators using BJT/ FET.
28. Design of Collpitt"s oscillators using BJT, Design of Hartly oscillators using BJT.
29. Study of Frequency response of Common Source (CS) amplifier.
30. To study different VI using NI Basic Electronics modules.
31. Active Filter Applications – LPF, HPF (first order).
32. IC 565 – PLL Applications, IC 566 – VCO Applications.
33. 4 bit DAC using OP AMP.
34. To study different VI using NI Basic Electronics modules.

Course Outcomes (COs):

At the end of this course, the learner will be able to:
1. Acquire a basic knowledge in solid state electronics including diodes, MOSFET, BJT, and operational amplifier.
2. Develop the ability to analyze and design analog electronic circuits using discrete components.
3. Observe the amplitude & frequency responses of common amplification circuits.
4. Design, construct & take measurement of various analog circuits to compare experimental results in the laboratory with theoretical analysis.
5. Analyze & interface different VI using NI basic electronics modules.

EI 213	**Circuits & Networks Lab**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Third Semester (Core)**	**0 0 3 2**

List of experiments:

1. Milmann's Theorem
2. Reciprocity Theorem
3. Steady state response analysis of RL Network
4. Steady state response analysis of RC Network
5. Transient response in R-L and R-C Network: Simulation/hardware
6. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware
7. Determination of Impedance (Z) and Admittance(Y) parameters of two port network
8. Frequency response of LP and HP filters
9. Frequency response of BP and BR filters
10. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form
11. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB
12. Representation of poles and zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second order system using MATLAB
13. Determination of Laplace transform and inverse Laplace transformation using MATLAB
14. a) Study of RC low pass filter as an integrator
    b) Study of frequency response of low pass filter
15. a) Study of RC high pass filter as an differentiator
    b) Study of frequency response of high pass filter
16. Design of different clipper circuits
17. Study of different clamper circuits: positive, negative & bias
18. Design & study of Frequency response of two stage RC coupled amplifiers
19. Study of power amplifiers.

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Infer and evaluate the transient response of R-L-C networks.
2. Evaluate and analyze the two-port network parameters.
3. Compare the frequency responses of different filters.
4. Apply Laplace and inverse Laplace transforms.
5.

CS 223	**Data Structure & Algorithm Laboratory**	**L**	**T**	**P**	**C**
	B. Tech (ECE & EIE) Third Semester (Core)	**0**	**0**	**3**	**2**

Use of special data structures for solving real-life problems, Implementation of customized data structures and defining their access & retrieval mechanism, Analyzing merit & demerit of different data structures.

Course Outcome (CO):

At the end of the course, students are expected to

1. Be able to design and analyze the time and space efficiency of the data structure.
2. Be capable to identify the appropriate data structure for a given problem.

3. Able to apply concepts for solving real-life problems.

EI 204	**Sensors and Transducers**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester (Core)**	**3 1 0 4**

Unit-1	**Introduction:** General concepts and terminology of measurement systems, generalized measurement system, Review of performance characteristics of a measurement system, Statistical analysis of measurement data. Standards and Calibration. Transducers and sensors, classification, emerging fields of sensor technologies.
Unit-2	**Resistive transducers:** Potentiometers, metal and semiconductor strain gauges and their signal conditioning circuits, strain gauge applications: Load and torque measurement. Instrumentation amplifier-circuits and applications.
Unit-3	**Inductive transducers:** Transformer types (LVDT) and associated signal conditioning circuits, synchros. Tacho generators and stroboscope. Capacitive transducers, capacitive microphone.
Unit-4	**Piezoelectric transducers**: Charge amplifier and signal conditioning of PE transducers; photoelectric transducers, photo-voltaic cell, proximity sensors, Hall effect sensors, Magnetostrictive transducers, Basics of Gyroscope, Seismic instruments and accelerometers.
Unit-5	**Transducers for Industrial Instrumentation:** Thermocouples: Thermoelectric effects, laws of thermocouple, cold junction compensation techniques, thermocouple types, construction, measuring circuits, associated signal conditioning circuits of TC for temperature measurement. Resistance temperature detector (RTD), principle and types, construction requirements for industry, measuring circuits, 3/4 wire RTD. Thermistors, principle and sensor types, measuring circuits, linearization methods and applications. Digital displacement sensors. Semiconductor sensors.

Text Books:

3. Murthy D. V. S. ***Transducers and Instrumentation.*** Prentice Hall India Learning Pvt. Ltd., New Delhi (2008).
4. Patranabis, ***Sensors and Transducers.*** Prentice Hall India Learning Pvt. Ltd., New Delhi (2003).
5. Doebelin Ernest O. ***Measurement Systems - Application and Design.*** Tata McGraw-Hill, New York (2003).

Reference Books:

1. Neubert Hermann K. P. ***Instrument Transducers - An Introduction to their Performance and Design***. 2nd Edition, Oxford University Press, Cambridge (1999).
2. Waldemar Nawrocki. ***Measurement Systems and Sensors.*** Artech House (2005).
3. Sze Simon M. ***Semiconductor sensors.*** John Wiley & Sons Inc., Singapore (1994).

4. Nakra Bahadur C. **and** Chaudhry Krishan k. ***Instrumentation Measurement and Analysis.*** TATA McGraw-Hill, New Delhi (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Define the terminology, standards and characteristics of measurement systems.
2. Identify the transducers and sensors used in various applications.
3. Utilize the basic principles and techniques of various sensors and transducers in real applications.
4. Design various circuits using sensors and transducers.
5. Apply knowledge of Sensors and Transducer for practical implementations in engineering applications.

EI 205	**Signals & Systems**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester(Core)**	**3 1 0 4**

Unit-1 **CLASSIFICATION OF SIGNALS AND SYSTEMS:** Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Causal and Non-causal signal, Deterministic & Random signals, Energy & Power signals – Classification of systems- CT systems and DT systems – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

Unit-2 **ANALYSIS OF CONTINUOUS TIME SIGNALS:** Fourier series for periodic signals, Fourier Transform & properties, Laplace Transforms and properties

Unit-3 **LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS:** Impulse response, Transfer function, convolution integrals, correlation, Differential Equations, Fourier and Laplace transforms in Analysis of CT systems, Systems connected in series / parallel, Frequency response of first order and second order LTI systems.

Unit-4 **ANALYSIS OF DISCRETE TIME SIGNALS:** Nyquist sampling theorem & Baseband signal Sampling – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT – Z Transform & Properties

Unit-5 **LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS:** Impulse response – Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

Text Books:

1. Papoulis Athanasios.***Circuits and Systems: A Modern Approach.*** Holt, Rinehart, and Winston Publishers, New York (1980).
2. Lathi Bhagawandas P. ***Signal Processing and Linear Systems.*** Oxford University Press (1998).
3. Simon Haykin and Barry van Veen. ***Signals and Systems.***John Wiley and Sons (Asia) Private Limited (1998).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Develop an ability to classify a given signal and/or system.
2. Develop an ability to find if a systems is LTI or not.
3. Introduction to various transforms and their application to signals and/or systems.
4. Develop an understanding of relation between time domain and frequency domain.
5. Introduction to sampling and sampling theorem. & ability to analyze signal transmission through a LTI system.

EI 206	**Control System-I**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester(Core)**	**3 1 0 4**

Unit-1	**Mathematical modelling of linear time invariant systems (LTI):** System components and Differential equations of physical Systems – mechanical, electrical Systems, thermal, Pneumatic and hydraulic systems. Synchro pair, servo and stepper motors, servo valves; Concept of analogous systems. Laplace transforms, Transfer function, Solution of set of differential equations using Laplace transformation. Concept of poles and zeros. System order and type number. Brief introduction to non-LTI systems, distributed systems, discrete systems
Unit-2	**Block diagram and signal flow graph analysis:** Block diagram reduction techniques, Mason’s gain formula. Examples.
Unit-3	**System analysis (time-domain):** Time response of first-order and second- order systems. Steady state errors and error constants.
Unit-4	**Characteristics of feedback control:** Feedback Principles, Effect of feedback in stability, steady- state accuracy, transient accuracy, disturbance rejection, insensitivity, and robustness.
Unit-5	**Stability analysis:** Concepts of stability. Necessary conditions for Stability. Routh stability criterion. Relative stability analysis. Introduction to root- locus techniques.
Unit-6	**System analysis (frequency-domain):** Bode plots-phase and gain margins, Experimental determination of transfer function. Introduction to Polar Plots. Nyquist plots. Nyquist Stability criterion (time delay systems excluded).
Unit-7	**Compensator Design**: Design of lead, lag and lead-lag compensators, Design (and development) of simple control system.

Text Books:

1. Norman Nise S. ***Control Systems Engineering***. John Wiley & Sons (2010).
2. Ogata Katsuhiko. ***Modern Control Engineering***. Pearson, 5th Edition (2010)
3. Dorf Richard C. and Bishop Robert H. ***Modern Control Systems.*** Pear- son, 13th Edition (2017).
4. Goodwin Graham C., Graebe Stefan F., and Salgado Mario E. ***Control System Design***. Prentice Hall (2001).
5. Madan Gopal. ***Control Systems: Principles and Design***. Mcgraw Hill Publisher, 4th Edition (2012).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Learn the process of modelling linear time-invariant (LTI) dynamical systems in dual domains: in the time domain using ordinary differential equations and in the Laplace domain (s-domain)
2. Understand and analyse the behaviour of LTI systems qualitatively and quantitatively, both in the transient and steady-state regimes, and conclude how it impacts the stability and performance of the systems.
3. Understand the concept of feedback control.
4. Analyse qualitatively the frequency response of LTI systems and its relation to the transient and steady-state system performance.
5. Design feedback control systems meeting specific system performance requirements.

EI 207	**Digital Electronics**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester (Core)**	**3 1 0 4**

Unit-1 **Digital fundamentals:** Review of: Number Systems, complements general formula, Codes, Important Boolean theorems, Gates, SOP & POS form, Minterms and Maxterms, Karnaugh map Minimization upto 4 variables. Detailed Quine-McCluskey method of minimization.

Unit-2 **Combinational circuit design:** Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multipliers, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder, 7-segment display.

Unit-3 **Programable & memory devices:** Basic memory structure – ROM -PROM ,EPROM, EEPROM, EAPROM, RAM, Static and dynamic RAM Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field Programmable Gate Arrays (FPGA), Implementation of combinational logic circuits using ROM, PLA, PAL.

Unit-4 **Synchronous sequential circuits:** Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Conversion of flip-flops, Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

Unit-5 **Digital integrated circuits:** Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, DTL, TTL, ECL, MOS, CMOS. Schmitt triggers, Multivibrators.

Unit-6 **Analog to digital and digital to analog converters:** Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R 2R Ladder types – switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type – Single Slope type – Dual Slope type – A/D Converter using Voltage-to-Time Conversion – Over-sampling A/D Converters, Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion / setting time).

Text Books:

1. Mano M. Morris. ***Digital Logic & Computer Design***. Prentice Hall India Learning Pvt. Ltd., New Delhi (2004).
2. Kumar Anand A. ***Fundamentals of Digital Circuits***. Prentice Hall India Learning Pvt. Ltd., New Delhi (2014).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Have a thorough understanding of the fundamental concepts and techniques used in digital electronics for simplification of Boolean functions in minimum form.
2. Learn to design & analyze various combinational circuits.
3. Learn to design & analyze various sequential circuits.
4. Gaining familiarity with various logic families. Learn to evaluate various logic families based on important characteristics.

EI 208	**Power Electronics and Drives**	**L T P C**
	B. Tech (Electronics and Instrumentation Engg.)	
	Fourth Semester (Core)	**3 0 0 3**

Unit-1 **Introduction:** Power electronics – needs; special features; advantages. Power Semiconductor Devices: Power diode, power MOSFET, SCR, TRIAC, GTO, IGBT, MCT, etc.

Unit-2 **AC to DC Converters:** Single phase, three phase, half controlled and fully controlled converters.

Unit-3 **DC to DC Converters:** Principle of chopper operation, Control strategies, Types of chopper circuits, Buck, Boost, Buck-boost converter; Steady state time-domain analysis.

Unit-4 **AC to AC converters:** Introduction; single and three phase ac voltage controller; Single phase half-wave cyclo-converters.

Unit-5 **Dc to AC Converters:** Single phase and three phase voltage source inverters, Current source inverters, voltage control in single phase inverters, PWM inverters.

Unit-6 **Drives and Applications:** Control of DC motor using converters and choppers, Closed loop control scheme, Speed-torque characteristics and control of induction motor. Some other applications as suitable.

Text Books:

1. Rashid Muhammad H. ***Power Electronics: Circuits, Devices and Applications***. Pearson Education, London (2014).
2. Mohan Ned, Undeland Tore M. and Robbins William P. ***Power Electronics – Converters, Applications and Design***. John Wiley & Sons Inc., New York (2007).
3. Bimbhra, P. S. ***Power Electronics***. Khanna Publishers, New Delhi (1990).

Reference Books:

1. Williams Barry W. ***Power Electronics: Devices, Drivers and Applications***. Palgrave Macmillan Publishers, London (1992).
2. Lander Cyril W. ***Power Electronics***. Mc Graw Hill inc., US (1987).
3. Umanand Loganathan. ***Power Electronics: Essentials and Applications***. Wiley India Pvt. Ltd., New Delhi (2009)
4. Bose Bimal K. ***Modern Power Electronics and A.C. Drives***. Prentice Hall India Learning Pvt. Ltd., New Delhi (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the basic operations and characteristics of power semiconductor devices; and power converters.
2. To select the suitable switches and power converter topologies; and design suitable power stage and control for a given application.
3. To design appropriate power converter parameters for a given application.
4. To understand and select the drives for a given application.

EI 214	**Sensors and Transducers Laboratory**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester (Core Laboratory)**	**0 0 3 2**

List of experiments:

1. To study the strain gauge characteristics.
2. To study the characteristics and weight measurement by load cell
3. To study the construction of LVDT and its use in displacement and thickness measurement.
4. To study the flow measurement by differential pressure type transducer.
5. To study the characteristics of LDR, thermostat and thermocouples.
6. To study the testing and calibration of T, J, K, R and S thermocouples.
7. To study the voltage – intensity characteristics of a photo – transistor
8. To study the ramp response characteristics of filled in system thermometer.
9. To study step response of RTD and thermocouple.
10. To study force and torque transducers and the working details of electrical pressure probes
11. To study the characteristics of photoelectric tachometer.
12. To study Hal Effect Transducer.
13. To study the characteristics of Accelerometer Model.
14. To study the characteristics of Angular potentiometer transducer model.
15. To design LabVIEW VI for measurement of voltage, current and PQ.
16. Measurement of temp, depth etc. by optical fibre sensor.
17. To study the characteristics of piezoelectric sensors.
18. To study the operation of sensor and actuator modules.
19. To study the operation of DAQ system for application with sensor signals.
20. Data acquisition and storage of signals through serial/parallel port (or sound card) to PC
21. PC based data acquisition using add-on (PCI) card: analog/digital inputs

Course Outcomes (COs):

At the end of the course, students are expected to

1. Classify sensors, transducers and their brief performance specifications.
2. Understand the static and dynamic characteristics of measuring instruments.
3. Demonstrate the performance characteristics of various transducers and sensors.
4. Interpret the experimental results and draw meaningful conclusions.
5. Design and develop sensing elements for sensing physical quantities, including biomedical signals, in electrical form.

EI 215	**Control System Laboratory**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester (Core Laboratory)**	**0 0 3 2**

List of Experiments:

1. Study of first order and second order system responses-measurement of system parameters
2. Check the stability of a system. Report whether the system is stable, unstable, or marginally stable. Given the transfer function of the system.
3. Obtaining the closed loop transfer function of a complex block diagram
4. Obtaining response of a system for an arbitrary input
5. State variable analysis-controllability, observability
6. Design of state feedback
7. Design of observer
8. Simulation of Mass Spring Dashpot system, DC Motor Control
9. Use of MATLAB for simulating transfer functions, closed loop systems etc
10. Transfer function of Field controlled DC Motor.
11. Transfer function of Armature controlled DC Motor.
12. Introduction to Control system tool box.
13. Plotting of pole-zero configuration in s-plane for the given transfer function.
14. Determining the transfer function for given closed loop system in block diagram representation.
15. Plotting unit step response of given transfer function and find peak overshoot, peak time.
16. Plotting unit step response and finding rise time and delay time.
17. Finding state space representation of given closed loop system.
18. Plotting locus of given transfer function, locating closed loop poles for different value of k.
19. Plotting root locus of given transfer function and finding S, Wd, Wn at given root.
20. Plotting Bode plot of given transfer function.
21. Plotting Bode plot of given transfer function and finding gain and phase margin.
22. Plotting Nyquist plot for given transfer function and to compare their stability.
23. Plotting Nyquist plot for given transfer function and to discuss closed loop stability, gain and phase margin.
24. Solving the above problems (as directed by course coordinator) using LABVIEW.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Perform stability analysis for linear system.
2. Implement state observer & state feedback controller for linear system.
3. Analyze real time Mass, spring, Dashpot system & DC motors.
4. Apply the knowledge of control system toolbox to time & frequency responses of a linear system.
5. Analyze the closed loop stability of transfer functions using root locus, bode plot & Nyquist plot.

EI 216	**Digital Electronics Laboratory**	**L T P C**
	B. Tech (Electronics & Instrumentation Engineering) **Fourth Semester (Core Laboratory)**	**0 0 3 2**

List of Experiments:

1. Design and implementation of Adders and Subtractors using logic gates.
2. Design and implementation of code converters using logic gates.
3. BCD to excess-3 code conversion and vice-versa.
4. Binary to Gray code conversion and vice-versa.
5. To study a BCD to 7 Segment LED display.
6. Design and implementation of Multiplexer and De-multiplexer using logic gates and study of IC74150 and IC74154.
7. Study RAM (16x4)-74189 (Read and Write operations).
8. Design and implementation of encoder and decoder using logic gates and study of IC74145 and IC74147.
9. Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip-flops.
10. To (a) study S-R, J-K, D & T Flip-flops, (b) conversions of one Flip-Flop to another.
11. To study synchronous, asynchronous counter.
12. To study MOD counter, decade counter.
13. To implement 3 bit shift registers (a) parallel in parallel out, (b) parallel in serial out, (c) serial in parallel out, (d) serial in serial out using J-K flip-flop.
14. To implement 3-bit (a) up counter, (b) down counter, (c) up-down counter, (d) decade counter with count sequence 0 to 9.
15. To (a) Design and implement a mod-5 synchronous counter with a particular state sequence using D-Flip Flop. (b) Design and test Johnson counter.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Learn the basics of logic gates and importance of code conversions.
2. Construct basic combinational and sequential logic circuits, and verify their functionalities.
3. Design, test and evaluate various encoders, decoders, Multiplexers and De-Multiplexers.
4. Implement and demonstrate different shift registers.
5. Compare and design various types of counters.

EI 217	Power Electronics Laboratory	L T P C
	B. Tech (Electronics & Instrumentation Engineering) Fourth Semester (Core Laboratory)	0 0 3 2

List of experiments:

1. Study the characteristics of power switches (Diode, MOSFET, IGBT, SCR)
2. Study the operation of 1-phase half-wave controlled bridge rectifier (using DC motor or any other load).
3. Study the operation of 1-phase full-wave controlled bridge rectifier (using DC motor or any other load).
4. Study the operation of 3-phase half-wave controlled bridge rectifier (using DC motor or any other load).
5. Study the operation of 3-phase full-wave controlled bridge rectifier (using DC motor or any other load).

6. Study the open loop operation of DC-DC Buck converter.
7. Study the open loop operation of DC-DC Boost converter.
8. Study the open loop operation of DC-DC Buck-Boost converter.
9. Study the operation of 1-phase PWM inverter.
10. Study the operation of 1-phase Cyclo-converter.
11. Study the operation of four quadrant chopper with DC motor drive.
12. Design, implement and study the operation of a DC-DC converter (buck or boost or buck-boost) for a specific application.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Analyze the characteristics of diode, MOSFET, IGBT.
2. Analyze the Half-wave and Full-wave bridge rectifiers.
3. Analyze the operation of DC-DC converter, PWM inverter, cyclo-converter, 4-quadrant chopper.
4. Evaluate the various performance indices such as ripple factor.
5. Apply knowledge of Power Electronics for practical implementations in engineering applications.

EI 301	**Industrial Instrumentation-I** **B. Tech (Electronics & Instrumentation Engg.)** **Fifth Semester(Core)**	**L T P C** **3 1 0 4**

Unit-1	**Mechanical parameters:** Introduction: why are the measurements of these parameters important in industry? Different methods for measurement of motion parameters: Displacement (Linear and Angular), velocity, acceleration, vibration, torque, force, shock etc. Measurement of straightness, flatness, roundness and roughness. Typical case study/design example: Instrumentation system for motion measurement in industry.
Unit-2	**Temperature:** Introduction; Definitions, standards, unit systems; Physical effects (expansion, change in pressure, resistance change, thermoelectricity, radiation, change in the properties of paints and crayons); Mechanical thermometers (filled systems, metallic expansion etc.); Electrical (3/4 wire RTD, Thermocouples, Thermistor etc.) and Bolometers. High temperature measurements, Pyrometers and Semiconductor transducers.

Typical case study: Instrumentation system for Industrial temperature measurement and control.

Unit-3 **Viscosity:** Introduction; Various types and units of viscosity; Viscous fluid flow through capillary-derivation; Viscosity measurements- Differential pressure & Back pressure type capillary viscometers; Saybolt viscometer; Rotameter type viscometers; Searle's rotating cylinder viscometer; consistency meters etc.
Case study: Instrumentation system design for Viscosity measurement in industrial environment.

Unit-4 **Density:** Introduction; various types of densitometers (pressure head; Displacer, float based on Buoyancy effect; Gas bridge; vibration; ultrasonic etc.)
Case study: Instrumentation system design for Density measurement in industrial environment.

Unit-5 **Humidity and Moisture, etc.:** Introduction; Various Definitions; Psychrometers; Hygrometers (hair, wire electrode, electrolysis, dew cell etc.); Moisture measuring methods for granular materials, solid penetrable materials, web type materials etc.
PH, Conductivity measurements.
Typical case study: Humidity and moisture measurement system in industrial environment.

Text Books:

1. Doebelin, Ernest O. and Manik, Dhanesh N. ***Measurement Systems***. Tata McGraw Hill Education (India) Private Limited, Chennai (2017).
2. Patranabis, Dipak. ***Principles of Industrial Instrumentation***. Tata McGraw Hill Education Private Limited, New Delhi (2017).
3. Sawhney, A. K**. *A Course in Electronic Measurements and Instrumentation***. Dhanpat Rai & Co. (P) Limited, New Delhi (2015).
4. Nakra, Bahadur C. and Chaudhary, Krishan K. ***Instrumentation, Measurement and Analysis.***McGraw Hill Education India Private Limited, Chennai (2016).

Reference Books:

1. Liptak, Bela G. ***Instrument Engineers Handbook***. CRC Press, Florida (2012).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Identify different methods of measuring motion parameters.
2. Analyze the electrical and non-electrical methods of temperature measurement.
3. Describe various viscosity and density measurement devices used in industrial environment.
4. Illustrate different methods of humidity and moisture measurement.

EI 302	**Microprocessors & Micro Controllers**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Fifth Semester(Core)**	**3 1 0 4**

Unit-1 **8085 Microprocessor:** Architecture: General 8-bit microprocessor and its architecture, 8085 functional block diagram, architecture functions of different sections.
Instruction Sets: Instruction format, addressing modes, instruction set of 8085 CPU, instruction cycle, timing diagrams, different machine cycles, fetch and execute operations, estimation of execution time.
Assembly Language Programming: Assembly format of 8085, assembly directions, multiple precision arithmetic operations, binary to BCD and BCD to binary code conversion, ALU programming using look up table, stack and subroutines.

Unit-2 **Advanced Microprocessor:** Intel 8086/8088 Microprocessor: Architecture, Clock Generator, Resetting the microprocessor, Wait State Inserting, Bus Buffering, Interrupts, and Assembly Language Programming and Addressing Modes.

Unit-3 **Applications, Memory and I/O Interface:** Interfacing Memory: Classification of Memory, Address decoding (using logic gates, decoders and PAL), Interfacing Static RAM Interfacing EPROM, Designing Memory Modules (higher capacity say 512K) using memory chips. Interfacing I/O Devices. Application examples.

Unit-4 **Communication Interface:** Interfacing and assembly language monitor program for Key Board (one dimensional, two dimensional) and Seven-segment display, Stepper Motor through 8255A, Data transfer between two microprocessor based systems through 8255. 8237 DMA controller and interfacing with 8086 up Programmable communication interface- Intel 8251 USART. Programmable Interrupt Controller- 8259A.

Unit-5 **Microcontrollers:** Introduction to single chip microcontrollers: Intel MCS-51 family features, 8051/8031 architecture, pin configuration, I/O ports and Memory organization. Instruction set and basic assembly language programming. Interrupts, Timer/Counter and Serial Communication. MCS-51 applications: Square wave and pulse wave generation, LED, A/D Converter and D/A Converter interfacing to 8051. Introduction to PIC micro-controller.

Text Books:

1. Gaonkar Ramesh S. ***Microprocessor Architecture, Programming and application with 808***. Prentice Hall of India, New Delhi (2013).
2. Bhurchandi K. M. and Ray A. K. ***Advanced Microprocessors & Peripherals*.** Tata McGraw-Hill, New Delhi (2017)
3. Mazidi Muhammed A. and Mazidi Janice G. ***The 8051 Microcontroller and Embedded Systems*.** Pearson Education Limited, USA (2007).

Reference Books:

1. Brey Barry B.. ***The Intel Microprocessors***. PHI/Pearson Ed. Asia, New Delhi (2009).
2. Deshmukh Ajay V. ***MicrocontrollersTheory and Applications***. Tata McGraw-Hill, New Delhi (2018).
3. Tribel Walter A., Singh Avtar and Srinath N.K.. ***The 8088 and 8086 Microprocessors***.

Pearson Education Limited, USA (2013).
4. Hall Douglas V. ***Microprocessors & Interfacing***. Tata McGraw-Hill, New Delhi (2005).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Acquire knowledge and explain the architecture of µP 8085 and 8086/8088 and µC 8051/8031.
2. Understand the addressing modes and instruction set, and assembly language programming of µP 8085 and 8086/8088 and µC 8051/8031.
3. Understand and analyze the need and use of interrupt structure microprocessors and microcontrollers.
4. Understand the importance of memory interfacing.
5. Develop the microprocessor and microcontroller based applications.

EI 303	Biomedical Instrumentation	L T P C
	B. Tech (Electronics & Instrumentation Engg.) **Fifth Semester (Core)**	**3 0 0 3**

Unit-1 Introduction to biomedical instrumentation: Electro physiology: Review of physiology and anatomy, resting potential, action potential, Nerst equation, bioelectric potentials, cardiovascular dynamics, electrode theory, bipolar and uni-polar electrodes, surface electrodes, physiological transducers. Systems approach to biological systems, Safety consideration in the use of electrical systems for in-vivo measurements.

Unit-2 Bioelectric potential and cardiovascular measurements: EMG - Evoked potential response, EEG. ECG, phonocardiography, vector cardiograph, impedance cardiology, cardiac arrhythmias, pace makers, defibrillators. Blood pressure measurements – manual / automatic systems, invasive and non-invasive types, Sphygmomanometer, Blood flow measurements using ultrasonic and electromagnetic flow meters, plethysmography.

Unit-3 Respiratory and pulmonary measurements and rehabilitation: Physiology of respiratory system, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, artificial kidney machine.

Unit-4 Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through bio-telemetry, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques.

Unit-5 Recent trends: Medical imaging, X-rays, laser applications in biomedical field, ultrasound scanner, echo cardiography, CT Scan MRI/NMR, cine angiogram, colour Doppler systems, Holter monitoring, endoscopy, PET SCAN, MEMS applications in biomedical field, Prosthetic devices (artificial limbs) and therapies.

Text Books:

1. Cromwell, Leslie. Weibell, Fred J. and Pfeiffer, Erich A. ***Biomedical Instrumentation and Measurements***. Prentice Hall India Learning Pvt. Ltd., New Delhi (2014).
2. Kandpur, Raghbir S. ***Handbook of Biomedical Instrumentation***. Tata McGraw Hill, New Delhi (2015).

Reference Books:

1. Jog, Nandini K. ***Electronics in Medicine and Biomedical Instrumentation***. Prentice Hall India Learning Pvt. Ltd., New Delhi (2013).
2. Aston, Richard. ***Principles of Bio-medical Instrumentation and Measurement***. Merril Publishing Company, New York (1990).
3. Geddes, Leslie A. and Baker, Lee E. ***Principles of Applied Biomedical Instrumentation***. John Wiley, New York (2008).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Understand the fundamentals of Biomedical Instruments to solve the problems at the interface of engineering and biology.
2. Identify various Bio-potential and their specifications in terms of amplitude and frequency to measure certain important electrical and non-electrical parameters of human health care.
3. Learn to measure the respiratory rate and nervous systems related measurements using simulator.
4. Explain the medical assistance/techniques, robotic and therapeutic equipment for patient monitoring systems.
5. Implement several medical instruments in diagnosis, therapeutic treatment and imaging fields to solve healthcare related problems in human body.

EI 304	**Control System-II** **B. Tech (Electronics & Instrumentation Engg.)** **Fifth Semester (Core)**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Unit-1 **Review of transfer function-Shortcomings of transfer function modelling, state space analysis of systems:** concept of state, state variables, state vector, state space and state space equation of linear continuous time systems, matrix representation of state equations. Modelling in state space: representing an electrical network, representing a translational mechanical system, representing an electromechanical system: armature controlled DC motor, representing a nonlinear system: Simple pendulum, representing a MIMO system: any suitable example. Correlation between transfer function and state-space equations, Phase variable and canonical forms of state representation: controllable, observable, diagonal, Jordan canonical form. Time domain solution of state equations, state transition matrix (STM), computation of STM: Laplace transform approach, using Cayley Hamilton method, diagonalization method etc., interpretation and properties of the state transition matrix.

Unit-2	**Linear algebra:** Field, vector spaces, subspaces, linear combination, spanning set, linear dependence and change of basis, Cayley - Hamilton theorem, Norms of vectors and matrix, eigenvalues and eigenvectors, Computation of state transition Cayley Hamilton method.
Unit-3	**Similarity transformations, Stability in state space:** Asymptotic stability, BIBO stability, relation between them and effect of pole zero cancellation.
Unit-4	**Definition and test of controllability, observability, detectability and stabilizability:** Effect of pole - zero cancellation. State feedback controller design: using transformation matrix, direct substitution method, Ackermann's formula, state feedback controller design for tracking. Full-order and reduced-order observers, Introduction to Linear Quadratic problems.
Unit-5	**Non-linear system analysis:** Non-linear system behaviour, different methods of linearization, Lyapunov stability criterion. Phase plane analysis, singular points, constructing phase portraits, describing functions, existence of limit cycle, and stability of limit cycles.

Text Books:

1. Ogata Katsuhiko. ***Modern Control Engineering***. Prentice Hall Learning Pvt. Ltd., New Jersey (2009).
2. Nise, Norman S. ***Control Systems Engineering***. John Wiley, New York (2019).

Reference Books:

1. Slotine, Jean Jacques E. and Li, Weiping. ***Applied nonlinear control***. Prentice Hall Learning Pvt. Ltd., New Jersey (1991).
2. Vidyasagar, Mathukamalli. ***Nonlinear system analysis***. PHI, New Jersey (1991).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Represent any dynamical system in state space.
2. Perform state variables analysis for any dynamical system.
3. Implement basic principles and techniques in designing linear control systems.
4. Analyze the characteristics of nonlinear systems.
5. Apply knowledge of control theory for practical implementations in engineering applications.

EI 305	**Communication and Telemetry** **B. Tech (Electronics & Instrumentation Engg.)** **Fifth Semester(Core)**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Unit-1	**Introduction:** Review of signals and systems, Review of Fourier series and Fourier Transform, Modulation-need for modulation, Frequency translation.
Unit-2	**Analog Communication:** Principles of amplitude modulation: Modulation and Demodulation of AM, DSB/SC, SSB, VSB, methods of generation and Demodulation.

Principles of angle modulation: FM and PM, narrowband FM, wideband FM-frequency spectrum and power relation, methods of generation and Demodulation techniques for FM, Frequency Division Multiplexing (FDM).

Unit-3 **Sampling & Pulse modulation system:** Types of sampling-representation, spectra and circuit. Nyquist low pass sampling theorem, sampling of bandpass signals, PAM, PWM, PPM- spectra, generation and demodulation schemes, TDM system.

Unit-4 **Digital Communication:** Digital signals and their spectra, Quantization, PCM, DPCM, DM, ADM. Digital modulation schemes: ASK, PSK, FSK, DPSK, QPSK-generation and detection, signal space diagram and probability of error.

Unit-5 **Source Coding and Line Coding:** Line Coding, Information, entropy, Shannon's theorem, Source coding-Huffmann and Shannon Fano.

Unit-6 **Telemetry:** Introduction, definition, classifications of telemetry system, Purpose of telemetry, basic schemes, voltage, current and frequency telemetry, line length limitations. Concepts of Information transfer, bits, symbols, codes - source, line, channel, BCD, ABCII, BAUDOT, AMI, CMI, Manchester, HDBM, Block, and Hamming. Review of modulation and multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc. Remote control and Industrial Telemetering systems.

Text Books:

1. Proakis John G. and Salehi Mohammad. ***Communication Systems Engineering***. PHI, New Delhi (2001)
2. Taub Herbert and Schilling Donald L. ***Principles of Communication System***. McGraw Hill, Chennai (2013).
3. Haykin Simon. ***Communication Systems***. Wiley, New Jersey (2008).

Reference Books:

1. Patranabis Dipak. ***Telemetry principles***. Tata McGraw Hill, New Delhi (2013).
2. Gruenberg Elliot L.**.** ***Handbook of Telemetry and Remote control***. Tata McGraw Hill, Chennai (1967).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the generation and detection of amplitude modulation and frequency modulation techniques.
2. Demonstrate the concept of sampling and classify the performance of PAM, PWM and PPM techniques.
3. Discuss performance issues for different digital modulation techniques and apply them in communication system.
4. Analyze the source coding and line coding techniques and apply them in communication system.
5. Apply knowledge of telemetry for practical implementations in industrial telemetering system.

EI 311	**Microprocessors and Microcontrollers Lab**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) Fifth Semester(Core)	**0 0 3 2**

List of Experiments:

1. Programs for 8/16 Bit Arithmetic Operations (Using 8085).
2. Programs for Sorting and Searching (Using 8085, 8086).
3. Programs for String Manipulation Operations (Using 8086).
4. Programs for Digital Clock and Stop Watch (Using 8086).
5. Interfacing ADC and DAC.
6. Parallel Communication between Two Microprocessor Kits using Mode 1 and Mode 2 of 8255.
7. Interfacing and Programming 8279, 8259, and 8253.
8. Serial Communication between Two Microprocessor Kits using 8251.
9. Interfacing and Programming of Stepper Motor and DC Motor Speed control.
10. Programming using Arithmetic, Logical and Bit Manipulation Instructions of 8051Microcontroller.
11. Programming and Verifying Timer, Interrupts and UART Operations in 8031 Microcontroller.
12. Communication between 8051 Microcontroller kit and PC.
13. Microcontroller experiments based on VI.

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Represent the design using 8085 and 8086 microprocessor.
2. Model serial and parallel interfacing of 8086 microprocessor.
3. Implement 8051 microcontroller based systems.
4. Analyze the concepts related to I/O and memory interfacing.
5. Construct different waveforms using 8086 microprocessor.

EI 312	**Biomedical Instrumentation Lab**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) Fifth Semester(Core)	**0 0 3 2**

List of Experiments:

1. Study of different types of Bio-electrodes.
2. Study of Sphygmomanometer and Stethoscope.
3. Design of Instrumentation Amplifier.
4. Design of Active Band Pass filter and Notch filter.
5. Calculating Heart Rate (HR) using real-time ECG signal (Student Physiograph method).
6. Measurement of EEG using 10-20 electrodes system (Student Physiograph method).
7. Measurement of EMG (Student Physiograph method).
8. Acquisition and display of ECG signal from human subject using electrodes and signal conditioning circuits.

9. Calculation of %error in Blood Pressure (BP) measurement using Sphygmomanometer and Auto BP apparatus.
10. Frequency analysis of ECG and EEG signals.
11. Design of FIR filter using windowing techniques.
12. Design of IIR filter – Butterworth and Chebyshev filter approach.
13. Design of Notch filter for elimination of 50Hz from ECG signal.

Hardware (further practice)

1. EEG, ECG and EMG data acquisition using 32-channel Mobita Instrument
2. Detection of QRS component from ECG signals using analog circuits.

Course Outcomes (COs)

At the end of this course, the learner will be able to:

1. Experimentally perform computation of convolution and correlation sequences.
2. Analyze biomedical signals using DFT and FFT computation.
3. Implement basic principles and techniques in designing FIR, IIR filters biomedical signal analysis through experiments.
4. Analyze the ECG, EEG, and EMG signals and data reduction algorithms.
5. Apply knowledge of biomedical instrumentation for practical implementations of EEG, ECG, and EMG.

EI 313	**Communication and Telemetry Lab**	**L**	**T**	**P**	**C**
	B. Tech (Electronics & Instrumentation Engg.) Fifth Semester(Core)	**0**	**0**	**3**	**2**

List of experiments:

1. To study Amplitude modulation and demodulation using MATLAB.
2. To study FM Modulation and Demodulation using MATLAB.
3. To generate PAM, PWM and PPM signal using MATLAB.
4. To study pulse code modulation (PCM) and Differential pulse code modulation (DPCM) using MATLAB.
5. To generate ASK, FSK, PSK, QPSK signal using MATLAB.
   (a) Study of signal sampling and reconstruction using ST-8301 trainer kit.
   (b) Study of Nyquist criteria and aliasing.
6. Study of amplitude modulation and demodulation using BCT-01 and ST-8209 trainer kit.
7. Study of frequency division multiplexing and de-multiplexing of signal using ST-8209 trainer kit.
8. Study of 4-channel Time division multiplexing (TDM) and de-multiplexing (TDD) using BCT-09 and ST-8304 trainer kit.
9. To study TDM pulse code modulation transmitter and receiver trainer kit ST-8304 and ST-8305.
10. To study ASK, FSK and PSK modulation and demodulation using ST-8308 and ST-8309 trainer kit.
    (a) To study delta modulation and demodulation using ST-8306 trainer kit.
    (b) To study Adaptive delta modulation and demodulation using ST-8306 trainer kit.
11. To study NRZ (L), NRZ (M), RZ and Manchester code and its detection using ST-8307 and ST-8308 trainer kit.
12. To study error check codes (parity coding, Hamming coding) using ST-8304.

13. Study of Pseudo random sync code generator using ST-8304.
14. Design and implementation of a MATLAB based SIMULATOR for generating different telemetry data streams
15. To Process Large Telemetry Data Sets for Biomechanical Performance Analysis using MATLAB.

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Analyze various analog and digital modulation schemes using MATLAB and trainer kit.
2. Identify various signals that can be generated using MATLAB.
3. Examine various signal processing techniques using different types of kit.
4. Explain various codes and their detection techniques using different kits.
5. Develop MATLAB based simulator to generate telemetry data stream.

		L	T	P	C
EI 314	**Virtual Instrumentation Lab**				
	B. Tech (Electronics & Instrumentation Engg.) Fifth Semester(Core)	**1**	**0**	**3**	**3**

List of experiments:

1. Creating Virtual Instrumentation for simple applications
2. Programming exercises for loops and charts
3. Programming exercises for clusters and graphs.
4. Programming exercises on case and sequence structures, file Input / Output.
5. Data acquisition through Virtual Instrumentation.
6. Developing voltmeter using DAQ cards.
7. Developing signal generator using DAQ cards.
8. Simulating reactor control using Virtual Instrumentation.
9. Real time temperature control using Virtual Instrumentation.
10. Real time sequential control of any batch process.
11. Data Acquisition using DAQs and NIELVIS.
12. Experiments using myRio and cRios.
13. Experiments using LabVIEW and motion system.
14. Biomedical application of LabVIEW

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Create Virtual Instrumentation for simple applications.
2. Develop voltmeter and signal generator using Virtual Instrumentation.
3. Design real time controllers using VI software.
4. Design experiments using myRio and cRio.
5. Design experiments using LabVIEW.

EI 306	Industrial Instrumentation-II B. Tech (Electronics and Instrumentation Engg.) Sixth Semester (Core)	L T P C 3 1 0 4

Unit-1 **Level Measurement:** Significance of level measurement in industry, Gauge glass technique coupled with photo electric readout system –float type level indication, Level measurement using displacer and torque tube, Bubbler system. level measurement – differential pressure method, Electrical types of level gauges using resistance, capacitance, nuclear radiation and ultrasonic sensors, Different scheme to realize level switches.

Unit-2 **Pressure Measurement:** Significance of pressure measurement in industry, Definition of absolute pressure, gauge pressure and vacuum, their relation and units of pressure, Non-Electric type pressure measurement: manometers: U-tube, well type, Elastic type pressure gauge: Bourdon tube, Diaphragm and Bellows, Electrical methods: elastic elements with LVDT, Measurement of vacuum: McLeod gauge , Knudsen gauge, thermal conductivity gauges, Ionization gauge cold cathode and hot cathode types, Electrical pressure transmitter, Testing and calibration of pressure gauges: dead weight tester.

Unit-3 **Flow Measurement - Mechanical Type Flowmeters:** Significance of flow measurement in industry, Basics of flow measurement: flow rate, volumetric flowrate and mass flowrate, Flow profile: Laminar, translational and turbulent, Reynolds number, classification of flowmeters, Differential Pressure Flowmeters, Theory of fixed restriction variable head type flow meters: orifice plate, venturi tube and flow nozzle, installation of head flow meters- piping arrangement and flow conditioners, Pitot tube, Variable area type flowmeters: Rotameter, Positive displacement flow meters : constructional details and theory of operation of mutating disc, reciprocation piston, oval gear and helix type flow meters, Mass flowmeters: Coriolis and Thermal, Calibration of flow meters – dynamic weighing method.

Unit-4 **Flow Measurement - Electrical Type Flowmeters:** Principle and constructional details of electromagnetic flow meter, different types of excitation schemes used and installation guidelines, Turbine flowmeter, Ultrasonic flowmeters, Laser Doppler anemometer, Vortex shedding flow meter, Solid flow rate measurement, Guidelines for selection of flow meter.

Unit-5 **Industrial Safety and Specifications Safety:** Introduction, electrical hazards, hazardous areas and classification, Non-hazardous areas, Enclosures – NEMA types, fuses and circuit breakers, protection methods: purging, explosion proofing and intrinsic safety, Specification of instruments, preparation of project documentation, process flow sheet, Instrument index sheet, Instrument specification sheet, panel drawing and specifications.

Text Books:

1. Jain, R.K. ***Mechanical and Industrial Measurements.*** Khanna Publishers, New Delhi.
2. Johnson Curtis D. ***Process Control Instrumentation Technology.*** Prentice Hall publishers, United States (2005).
3. Singh, S.K. ***Industrial Instrumentation and Control.*** Tata McGraw Hill Publishing Ltd., New Delhi (2009).

Reference Books:

1. Patranabis Dipak. ***Principles of Industrial Instrumentation.*** Tata McGraw Hill Publishing Ltd., New Delhi, (2013).
2. Andrew William G. ***Applied Instrumentation in Process Industries – A survey. Vol. 1 & Vol. 2.*** Gulf Publishing Company, Houston, (2001).
3. Doebelin Ernest O. ***Measurement systems Application and Design.*** International Student Edn, McGraw Hill Publishing Ltd, New York (2001).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Remember the techniques for level and pressure measurement.
2. Apply the knowledge for selection and applications of flow meter.
3. Understand safety regulations for industries.
4. Evaluate project documentation, process flow sheet, Instrument index sheet, Instrument specification sheet, panel drawing and specifications.

EI 307	**Process Control Engineering**	**L T P C**
	B. Tech (Electronics and Instrumentation Engg.)	**3 1 0 4**

Sixth Semester (Core)

Unit-1 **Introduction to process control:** Need and objectives of process control, Process control hierarchy. Introduction to multivariable control and distributed control. Regulatory control and set-point tracking control. Programmable logic controllers. Need of process model. Distributed control system. Human-machine interface.

Unit-2 **Mathematical modelling using first principles:** Modelling of interacting systems. Empirical modelling (linear) from process data (step, pulse, and random signals). Linear least square method for parameter estimation.

Unit-3 **Mechanical, Hydraulic and Pneumatic System Components:** Servo-valves. ON-OFF control. Modified ON-OFF control. Multi-position control. Proportional control. Effect of integral and derivative action. Proportional-Derivative (PD), Proportional-Integral (PI) control. Proportional-Integral- Derivative (PID) control. Advantages and limitations of various control strategies and measures to overcome the limitations. Practical implementation of controllers. Performance criteria for controllers. Tuning of PID controllers (minimum one open loop and one closed loop method).

Unit-4 **Advanced process control:** Feedforward control. Cascade control. Ratio control. Time-delay compensation. Override control. Inferential control.

Unit-5 **Control of multivariable process:** Relative gain array method for inter- action analysis. Brief introduction to decentralised control. Decoupling and strategies for reducing control loop interactions. Overview of model predictive control.

Unit-6 **Process control instrumentation and plant design:** Overview of different final control elements, transducers and transmitters. Various industrial communication protocols. Plantwide control system design. Piping and instrumentation diagram.

Unit-7 **Case studies (self study/Group presentations):** Control strategy for boiler drum level and combustion chamber. Control strategy for binary distillation column. Control of CSTR. Safety in process plants with different case studies.

Text Books:

1. Dale, Seborg. Edgar, Thomas and Mellichamp, Duncan. ***Process Dynamics and Control***. Wiley, United States, (2003).
2. Ogunnaike, Babatunde A. and Ray, Harmon W. ***Process Dynamics, Modeling, and Control***. Oxford university press, England (1994).
3. Bequette, B. Wayne. ***Process Control: Modeling, Design and Simulation***. Prentice Hall Publishing, New York (2003).
4. Luyben, William. ***Process Modeling, Simulation and Control***. Tata McGraw hill publishers, New York (2014).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Understand the objectives of process control.
2. Apply first principle and empirical modeling techniques for mathematical modeling.

3. Implement techniques for designing feedback controllers.
4. Apply the advanced process controllers for multivariate process.
5. Apply knowledge of control elements, transduces and transmitters in practical systems.

EI 308	Digital Signal Processing	L T P C
	B. Tech (Electronics and Instrumentation Engg.) Sixth Semester (Core)	3 1 0 4

Unit-1 Introduction: Review of different discrete time signals and systems-Properties, Sampling techniques, quantization, quantization error, Nyquist Rate and aliasing effect.

Unit-2 Discrete Time System Analysis: Impulse Response-Frequency response-Pulse Transfer Function-Z-Transform and its properties, inverse Z-Transform, difference equation-solution by z-transform, application to discrete system-stability analysis, frequency response-convolution, DTFT-magnitude and phase representation, Representation of LTI system- direct form-I, direct form-II, cascade form and parallel form structures.

Unit-3 DFT and FFT: Frequency domain sampling, DFT and its properties, circular convolution, linear convolution using DFT, Computation of DFT using FFT-DIT and DIF using Radix 2 FFT-Butterfly computation.

Unit-4 Digital Filter Design Techniques: FIR and IIR filter realization-parallel and cascade form, characteristics of practical frequency selective filter, design of FIR filters by windowing, need for choice of window, linear phase characteristics, characteristics of Analog Butterworth and Chebyshev filters, design of IIR filters from continuous-time filters-Impulse invariance and bilinear transformation methods.

Unit-5 Multirate Signal Processing: Introduction to multirate digital signal processing, sampling rate conversion, filter structures, multistage decimator and interpolators, digital filter banks.

Unit-6 Introduction to DSP Processors: Introduction to DSP Architecture-Harvard architecture- Overview of architecture and instruction set of TMS320C5X.

Text Books:

1. Proakis, John G. and Manolakis, Dimitris G. ***Digital Signal Processing Principles, Algorithms and Applications.*** Prentice Hall publishing, New York (2000).
2. Venkataramani, Balasubramaniam and Bhaskar, M. ***Digital Signal Processor Architecture, Programming and Application.*** Tata McGraw Hill publisher, New Delhi (2002).

Reference Books:

1. Mitra, Sisir K. ***Digital Signal Processing: A computer-based approach.*** Tata McGraw-Hill publisher, New Delhi (1998).

2. Oppenheim and Schafer. ***Discrete-time Signal Processing.*** Prentice Hall publishing Ltd., New York (2000).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Interpret, represent, describe and process signals and systems.
2. Analyze and explain the discrete time systems.
3. Understand and analyze the transformation techniques and their computation.
4. Analyze the types of filters and their design for digital implementation.
5. Apply knowledge of the programmability in digital signal processor and quantization effects.

EI 315	Instrumentation Lab B. Tech (Electronics and Instrumentation Engg.) Sixth Semester (Core)	L T P C 0 0 3 2

LIST OF EXPERIMENTS:

1. Instrumentation amplifier using Op-Amps-gain and CMRR.
2. Active notch filter/Narrowband active filter (using Op-Amp).
3. Analog to digital converter circuit.
4. Digital to analog converter circuit.
5. Frequency to voltage converter- Voltage to frequency converter.
6. Astable and monostable multivibrators using IC 555.
7. Voltage regulators: IC 723, 78XX, 79XX family.
8. Design of PLL for given lock and capture ranges, frequency multiplication.
9. Study of dead weight tester and calibration of pressure gauge.
10. Measurements using Photocell/LDR.
11. Temperature measurement using RTD.
12. Temperature measurement–using thermocouple–using diode.
13. Measurement of distance using ultrasonic method.
14. Measurement of PH and viscosity.
15. Measurement of level- Flow measurement.
16. Measurement of Discharge coefficient of orifice plate.
17. Calibration of thermocouple and signal conditioning.
18. Calibration of RTD and signal conditioning of RTD.
19. Study of spectrum with UV-Visible Spectrophotometer and IR Spectrophotometer.
20. Level transmitter.
21. pH meter standardization and measurement of pH values of solutions.
22. Data Acquisition using different DAQs and LabVIEW programming.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand and analyze different measuring devices, filters, converter circuits, and voltage regulators.
2. Understand calibration of meters, sensors and transmitters.
3. Experimentally measure industrial process parameters such as flow, level, temperature pressure and viscosity.

4. Measure and analyze pH, conductivity, UV absorbance and transmittance.
5. Use LabVIEW programming for data acquisition.

EI 316	Industrial Process Control and Automation Lab B. Tech (Electronics and Instrumentation Engg.) Sixth Semester (Core)	L T P C 0 0 3 2

LIST OF EXPERIMENTS:

1. Automatic Level Control in a Tank.
2. Automatic Speed Control of DC Motor.
3. Automatic Flow Control in a Process.
4. Automatic Temperature Control in a Process.
5. Smart Traffic light Controller.
6. Robot Arm Control.
7. Design of an Alarm System for Fire Detection.
8. Dynamic simulation for On-Off Temperature Control & Ratio Control.
9. Dynamic simulation for Effect of PI Controller on Flow Control Loop & Level Control Loop.
10. Dynamic simulation for Split Range Pressure Control & Effect of PI Controller on Pressure Control Loop.
11. Dynamic simulation for Direct and Cascade Control & Feedback and Feed forward Control.
12. Three Element Boiler Control, Control Valve Characteristics & Inherent Characteristics Co-Efficient of Control Valve.
13. Basic Instrumentation Troubleshooting System.
14. Simulation of process industries: a) Refinery, b) basic process models, c) Fertilizer, d) Power & utilities.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Apply and analyze controllers for real time process and systems.
2. Analyze the effect of various controllers for real time systems.
3. Implement control of robotic arm and smart traffic light controller.
4. Design controllers for flow, level and pressure control.
5. Design Direct and Cascade Control & Feedback and Feed forward Control for industrial process.

EI 317	Digital Signal Processing Lab B. Tech (Electronics and Instrumentation Engg.) Sixth Semester (Core)	L T P C 0 0 3 2

LIST OF EXPERIMENTS:

1. To represent basic signals (unit step, unit impulse, ramp, exponential, sine and cosine) using MATLAB.

2. Determine response of discrete-time systems for test inputs using MATLAB.
3. To perform operation such as a) addition, b) subtraction c) shifting d) multiplication, and e) convolution using MATLAB.
4. Program to obtain linear and circular convolution for two finite length sequences using MATLAB.
5. To understand sampling theorem using MATLAB.
6. Program for computing correlation of two sequences using MATLAB.
7. To design Analog filters (low-pass, high – pass, band –pass, band -stop) using MATLAB.
8. To design digital IIR filters (low-pass, high-pass, band-pass, band-stop) using MATLAB.
9. To design FIR filters using windows technique using MATLAB.
10. To develop a program for computing parallel and cascade realization values of IIR digital filter using MATLAB.
11. To develop a program for computing Z-transform, inverse Z-transform of a rational transfer function using MATLAB.
12. To design digital filters-Butterworth and Chebyshev using MATLAB.
13. To determine DTFT, DFT and FFT using MATLAB.
14. Introduction to Code composer studio and study the architecture of DSP-6713 processor.
15. Computation of N-pt DFT and FFT of a given sequence using DSP processor.
16. Determine power spectrum using processor.
17. Interfacing of on chip peripherals with a DSP kit.
18. Design FIR filters using a DSP kit.
19. Design IIR Filter using a DSP kit.
20. Audio-Codec and its applications using DSP processor.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the handling of discrete/digital signals using MATLAB.
2. Predict the parameters of N-pt. DFT and FFT of a given sequence using DSP processor.
3. Analyze the spectral parameter of window functions.
4. Design the architectures of IIR and FIR filters for band pass, band stop, low pass and high pass filters using MATLAB and DSP kit.

EI 318	**Simulation, Design and Fabrication Lab**	**L**	**T**	**P**	**C**
	B. Tech (Electronics and Instrumentation Engg.) Sixth Semester (Core)	**0**	**0**	**3**	**2**

LIST OF EXPERIMENTS:

1. Combinational Logic: Basic Gates, Universal Gates, Adder/ Substractor.
2. Decoders, Address decoders, Comparator Multiplexer.
3. Multipliers, parity generator, ALU.
4. Sequential Logic: D-Latch, D-Flip Flop, JK-Flip Flop, Registers.
5. Shift Registers (serial-to-parallel, parallel-to-serial), Cyclic Encoder /Decoder.
6. Ripple Counters, Synchronous Counters.
7. Memories and State Machines: Read Only Memory (ROM), Random Access Memory (RAM).
8. Mealy State Machine, Moore State Machine, Arithmetic Multipliers using FSMs.
9. FPGA System Design: Demonstration of FPGA and CPLD Boards, Demonstration of

Digital design using FPGAs and CPLDs.

10. Implementation of UART/Mini Processors on FPGA/CPLD etc.
11. Simulation and design using MATLAB, LabVIEW.
12. Simulation and design of instruments, process plants and sensors.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Applying basic knowledge of science and mathematics.
2. Identify, formulate and analyze problems from literature.
3. Design and analyze experiments and analyze the results.
4. Design systems and algorithms.

EI 401	**Analytical and Optical Instrumentation**	**L T P C**
	B. Tech (Electronics and Instrumentation Engg.)	
	Seventh Semester (Core)	**3 0 0 3**

Unit-1 **Absorption Spectroscopy:** Introduction: Review of Oscilloscope. Absorption Spectroscopy-Quantitative aspects, photometer and spectrophotometer designs. Molecular UV and V absorption Spectroscopy, Absorbing Species, Application in qualitative and quantitative analysis, Photo acoustic spectroscopy. Molecular fluorescence, phosphorescence and chemiluminescence spectroscopy. Atomic spectroscopy, Atomic absorption types, Atomic fluorescence types. Emission spectroscopy with Plasma, Arc, Spark, Flame emission type. IR absorption spectroscopy qualitative and quantitative analysis, IR emission spectroscopy. Raman spectroscopy. Various types of the spectroscopy and their applications.

Unit-2 **Spectroscopic Analysis:** NMR - application to proton and other isotopes, environmental effects, ESR. X-ray spectroscopy, fluorescence, absorption, diffraction. Mass spectroscopy - identification of pure compounds, Molecular secondary ion mass spectrometry. Application of GM counter, proportional counter, solid state detectors and scintillation counter.

Unit-3 **Chromatography:** Plate theory, qualitative and quantitative analysis, Computerized system; Gas-liquid chromatography, Gas solid type, HPLC, Partition Chromatography, Absorption chromatography, Ion-exchange chromatography, Size exclusion chromatography, Superficial type. Planer chromatography: Thin layer, paper and Electro chromatography.

Unit-4 **Electron Microscopy:** Electron spectroscopy and its applications. SEM with auxiliary equipment. FESEM. Electrochemical cells, cell potentials, electrode potentials, Reference electrodes, Metallic electrodes, Membrane electrodes, Potentiometric methods.

Unit-5 **Optical Instrumentation:** Principle of Optical fiber - Numerical aperture - Types of optical fibers - Optical sources. Optical detectors – LED LASER, Photodiode, light Dependent resistors and their characteristics. Basics of Optical Fibre Sensing-Fibre optic sensors - Different types of modulators – Industrial application of optical fibres: Measurement of pressure, temperature, current, voltage, liquid level and strain. Interferometers(and applications in metrology) - Interference filters - Optical spectrum analyser - Lasers - Population inversion - Semiconductor lasers - Laser Doppler Anemometry - Medical application of lasers.

Text Books:

1. Khandpur Raghbir. ***Handbook of Analytical Instruments***. Tata Mc-Graw Hill publishing Co. Ltd., New Delhi (2003).
2. Lipta, Bella G. ***Process Measurement and analysis***. CRC press, United States (2003).
3. Willard Merritt, and Dean Settle. ***Instrumental Methods of Analysis***. CBS Publishing and Distribution Ltd, New Delhi (2004).

Reference Books:

1. Rousseau Francis and Rouesssac Annick. ***Chemical analysis Modern Instrumentation Methods & Techniques***. John Wiley & sons Ltd., United States (2007).
2. Robinson James W. ***Undergraduate Instrumental Analysis***. Marcel Dekker Inc., New York (2005).
3. Ewing Gallen W. ***Instrumental Methods of Analysis***, Tata McGraw Hill Publisher Ltd., United States (1975).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain various techniques of absorption & emission spectroscopy, chromatography, electron microscopy & recognize optical instruments.
2. Use analytical instrumentation techniques for industrial, biomedical, sensing & other applications.
3. Analyze the different types of spectroscopy, chromatography, microscopy & optical sensors.
4. Evaluate effectiveness & limitations of different classes of analytical & optical instruments.
5. Design & develop improved analytical & sensing techniques based on modern industry standards.

HS 401	**Managerial Economics**	**L T P C**
	B. Tech (All Branch) Seventh Semester(Core)	**3 0 0 3**

Course Objective:

The Objective is to impart the basic knowledge about the working of the firms in a competitive environment in regards to optimization of cost, price, output and resource use as well as familiarizing the learners about the macro-economic environment in which the business firms operate.

Unit-1 Basic concepts: Nature, Scope and Application of Managerial Economics.

Unit-2 Theory of Consumer Behavior and Demand Analysis: Demand Analysis, Elasticity of Demand, Demand Estimation and Forecasting, Supply, Equilibrium of a firm and industry.

Unit-3 Cost Estimation: Theory of Cost, Analysis of Economies of Scale.

Unit-4 Theory of Production: Isoquant, Isocost line, Cobb-Douglas Production Function.

Unit-5 Market Structure: Perfect Competition, Monopoly and Monopolistic Competition.

Unit-6 Macroeconomic Issues: National Income, Inflation and Business Cycle.

Unit-7 International Trade: Comparative advantage and H-O model.

Reference Books:

1. Salvatore, Dominick: Managerial Economics: Principles and Worldwide Applications, Oxford university Press, New Delhi.
2. Pindyck, Robert S. & Daniel L. Rubenfeld: Microeconomics, Prentice-Hall of India Private Limited, New Delhi.
3. Baye, Michael R. & Jeffrey T. Prince: Managerial Economics and Business Strategy, McGraw Hill Education (India) Private Limited, Chennai.
4. Koutsoyiannis, A.: Modern Microeconomics, Macmillan Press Limited, London.
5. Mankiw, N. Gregory: Principles of Economics, Cengage India.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Take better economic decisions in regards to cost, price fixation and determination of optimum level of output.
2. Situate themselves as managers of business entity, within the overall macro-economic environment which will, in turn, help them to take effective economic and managerial decisions.

EI 498	**Project I** **B. Tech (Electronics and Instrumentation Engg.)** **Seventh Semester (Core)**	**L T P C** **0 0 9 6**

Course Outcomes (COs):

At the end of the course, students are expected to

1. Identify real world engineering problems after studying varied domains and finalize problem statement(s).
2. Analyze, design and implement solution methodologies considering technical, social and environmental constraints.
3. Apply different engineering tools like programming techniques etc. for solution.
4. Apply various hardware and software tools and evaluation metrics for formulating technical report.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer, by adhering to professional ethics and applying different illustrative tools and evaluation metrics.

		L	T	P	C
MS-401	**BUSINESS MANAGEMENT**				
	B.Tech- All Branch- 7/8th Semester (Core)	3	0	0	3

Course Objectives:

1. Graduates will be able to demonstrate the ability to recognise and analyse business problems by using technical and analytical skill.
2. Graduates will demonstrate the ability to integrate engineering and management techniques to aid planning and control within a changing context to meet stakeholder interests.
3. Graduates will demonstrate their role as managers and entrepreneurs and contribute to betterment of the society.

Course Contents:

Overview of Management: Definition – Management, Role of managers, Evolution of Management thought , Principles of Management, Planning: Nature and purpose of planning, Planning process, Types of plans, Decision Making, Types of decision, Decision Making Process, Rational Decision Making. Organizing: Nature and purpose of organizing, Organization structure, Formal and informal groups in organization, Line and Staff authority, Span of control, Centralization and Decentralization, Delegation of authority, Staffing: Selection and Recruitment, Training, Performance Appraisal, Directing: Creativity and Innovation, Controlling: Process of controlling, Types of control, Budgetary and non-budgetary control.

Introduction to Marketing: Challenges of modern marketing; Customer value and satisfaction; Market-oriented strategic planning; Marketing Information System. Scanning the marketing environment; Buyer Behaviour; Consumer Behaviour; Market segmentation; Targeting and Positioning (STP).

Organizational Behaviour: Introduction to OB; Foundations of Individual Behaviour; Attitudes and Job Satisfaction; Personality and Emotions; Perception and Individual Decision Making; Motivation & its theories; Understanding Work Teams; Leadership & its theories ; Group Dynamics; Foundations of Group Behaviour; Stress Management; Conflict Management, Organization Culture; Elements and types of culture.

Texts books/References:

1. S. P. Robbins and T. A. Judge. ***Organizational Behaviour***. 17/e, Prentice-Hall of India Pvt. Ltd., 2017.
2. Charles W.L. Hill, Steven L. Mc Shane. ***Principles of Management (SIE)***. Tata McGraw- Hill Education pvt. Ltd., 2007
3. Udai Pareek. ***Understanding Organizational Behaviour***. 2/e, Oxford University Press, 2008.
4. T. S. Bateman and S. A. Snell. ***Management***. 8/e, TMH, 2008.
5. K. Aswathappa. ***Organisational Behaviour***. 12/e, Himalaya Publishing House, 2016.
6. Kotler, P., Keller, K. ***Marketing Management***. 15th Global Edition, Pearson Education, 2016
7. Mullins, J., Walker, O., and Harper, B.J. ***Marketing Management: A Strategic Decision-Making***. 8th edition McGraw-Hill Education, 2012
8. Ramaswamy & Namakumari. ***Marketing Management***. 6th Edition, SAGE Publication, 2018

Course Outcome:

1. The students will get a thorough knowledge of different management concepts and their relevant applications in day to day organizational commitments.
2. Demonstrate how the organizational behaviour can integrate in understanding the motivation (why) behind behaviour of people in the organization.
3. Students will demonstrate effective understanding of relevant functional areas of marketing management and its application

EI 499	**Project II** **B. Tech (Electronics and Instrumentation Engg.)** **Eighth Semester (Core)**	**L T P C** **0 0 9 6**

Course Outcomes (COs):

At the end of the course, students are expected to
1. Demonstrate a sound technical knowledge of their selected project topic(s).
2. Design engineering solutions to complex problems utilising a systematic approach.
3. Conduct an engineering project and analyze and infer findings of the research work.
4. Communicate with engineers and the community at large in written and oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer, by adhering to professional ethics and applying different illustrative tools and evaluation metrics.

ELECTIVE-I

EI 331	IC and VLSI Design	L	T	P	C
	B. Tech (Electronics & Instr. Engg.) Professional Core Elective	3	1	0	4

Unit-1 **Introduction:** Revison, Discrete circuits to Integrated circuits, Ge/Si, BJT/ MOSFET/ CMOS Historical Perspective, Issues in Digital Integrated Circuit Design, Terminology, Quality Metrics of a Digital Design - Cost of an Integrated Circuit, Functionality and Robustness, Modularity, Performance, Power and Energy Consumption. Y-chart.

Unit-2 **IC Technology:** The Manufacturing Process - Sand to silicon, Czochralski process, Float zone, The Silicon Wafer, Oxidation, Diffusion, Deposition, Photolithography, Etching, contact, passivation. Some Recurring Process Steps Simplified CMOS Process Flow, N-well, P-well, Twin-Tub, Design Rules micron and lambda based.

Unit-3 **MOSFET Device:** Ideal I-V and C-V characteristics, non ideal I-V effects, DC transfer characteristics, Switch level RC delay models, The MOSFET Transistor, A First Glance at the Device, The MOS Transistor under Static Conditions, Dynamic Behavior, The Actual MOS Transistor, Some Secondary Effects, Band bending & threshold voltage, Scaling, Drain current equation V-I characteristics NMOS and PMOS, capacitance calculations, SPICE Models for the MOS Transistor, Interconnect & its Parameters — Capacitance, Resistance, and Inductance.

Unit-4 **The CMOS Inverter:** Introduction, The Static CMOS Inverter — An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter: The Static Behavior, Switching Threshold, Noise Margins, Performance of CMOS Inverter: The Dynamic Behavior, Propagation Delay: First-Order Analysis, Propagation Delay from a Design Perspective, Static & dynamic power dissipation, Energy, and power-delay product, Technology Scaling and its Impact on the Inverter Metrics.

Unit-5 **CMOS Combinational Circuits:** Design and analysis of Combinational Logic Gates in CMOS: Introduction, Static CMOS Design, NAND and NOR Complementary circuits, Sizing issues, Threshold voltage, Delay, Constraint based design. Bollean expression CMOS Implementation, Eulers path & Stick diagrams.

Text Books:

1. Kang, Sung-Mo and Leblebici, Yusuf. ***CMOS Digital Integrated Circuits Analysis & Design.*** Tata McGraw Hill Publisher, New York (2002).
2. Rabey, J. and Pedram, M. ***Digital Integrated circuits***. Prentice Hall Publisher, New York (2003).

Reference Books:

1. Pucknell & Eshraghian, “Basic VLSI Design”, (3/e), Prentice Hall of India Pvt Ltd., New York (1996).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the steps involved in IC fabrication.
2. Explain MOSFET device related issues and their impact on circuits.
3. Implement the logic circuits using CMOS technology.
4. Design &analyse various circuit configurations with basic constraints.
5. Analyse the merits of circuits according to the technology and applications change & understand the rapid advances in CMOS technology.

EI 332	Power Plant Instrumentation B. Tech (Electronics & Instr. Engg.) Professional Core Elective	L	T	P	C
		3	1	0	4

Unit-1 Introduction to the overall subject and familiarization with some general terminologies used in power industries-Various power generation techniques; load curves; performance parameters; cost and tariff; layout of a typical power plant.-Piping and instrumentation diagram-Thermodynamic cycle overview.

Unit-2 Thermal Power Plant: working; Instrumentation in fuel handling; feed water management; combustion control; Efficiency; drum level control; main steam temperature control; Ash handling; Flue gas handling.

Unit-3 Nuclear power plant: Overall plant working; radiation detection with various types of instruments; salient features of instrumentation in nuclear power plants; nuclear reactor control and allied instrumentation; Safety issues and measures.

Unit-4 Nonconventional power generation: Solar; wind; fuel cell etc.

Unit-5 Environmental concerns on various types of power plants: thermal; nuclear; wind; hydro; solar etc.

Text Books:

1. K. Krishnaswamy. ***Power Plant Instrumentation.*** Pearson education, Chennai (2011).
2. Gautam, Samsher. ***Power Plant Engineering.*** Vikas Publishing House Pvt. Ltd, New Delhi (2010).
3. Bansal, Kleeman & Melisa. ***Renewable Energy Sources & Conversion Technology.*** Tata McGraw Hill Publishers, New Delhi (1990).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Identify various power generation techniques in terms of their performance parameter.
2. Analyze piping and instrumentation layout diagram used in a power plant.
3. Understand thermal power plant engineering
4. Explain about Nuclear power plant and issues related to it.
5. Relate various Nonconventional power generation techniques and identify various causes that lead to environmental damage.

EI 333	Computer Networks B. Tech (Electronics & Instr. Engg.) Professional Core Elective	L	T	P	C
		3	1	0	4

Unit-1	**Data Communications:** Components – Direction of Data flow – networks – Components and Categories – types of Connections – Topologies –Protocols and Standards – ISO / OSI model – Overview of data, signal and transmission, Transmission Media – Coaxial Cable – Fiber Optics – Line Coding –Circuit Switching.
Unit-2	**Data Link Layer:**Types of Error – framing- detection and correction – Parity – LRC – CRC – Hamming code – flow Control and Error control protocols - stop and wait – go back-N ARQ – selective repeat ARQ- sliding window – HDLC. LAN - Ethernet IEEE 802.3 - IEEE 802.4 - IEEE 802.5 - IEEE 802.11, Multiple Access Protocols- Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CA, CSMA/CD.
Unit-3	**Network Layer:** Repeaters-Hub-Bridges-Router-Gateway, Internetworks – Packet Switching and Datagram approach – IP addressing methods – Subnetting – Routing – Distance Vector Routing – Link State Routing, IPV4, IPV6.
Unit-4	**Transport Layer:** Duties of transport layer – Multiplexing – Demultiplexing – Sockets – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion Control – Quality of services (QOS) – Integrated Services.
Unit-5	**Application Layer:** Domain Name Space (DNS) – SMTP – FTP – HTTP - WWW – Security – Cryptography.

Text Books:

1. Forouzan, Behrouz A. ***Data communication and Networking***. Tata McGraw- Hill Publisher Ltd. United States (2004).
2. Tanenbaum, Andrew S. ***Computer Networks.*** Prentice Hall Publishers Ltd., New York (1994).

Reference Books:

1. Kurose, James F. and Ross, Keith W. ***Computer Networking: A Top-Down Approach Featuring the Internet.*** Pearson Education, United States (2003).
2. Peterson, Larry L. and Davie, Peter S. ***Computer Networks.*** Morgan Kaufmann publisher, United States (2011).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Identify the issues and challenges in the architecture of a computer network
2. Explain the ISO/OSI seven layers in a network
3. Apply the protocols at different layers of a network hierarchy.
4. Identify security issues in a network.

EI 334	**PC Based Instrumentation**	**L T P C**
	B. Tech (Electronics & Instr. Engg.) Professional Core Elective	**3 1 0 4**

Unit-1 **Introduction:** Necessity and functions of computers. Level of automation and economy of computer control. Centralized computer control Vs distributed computer control.

Unit-2 **Computer architecture:** Micro and mini-computer, functional models of I.O. system, interfacing, Sampling.

Unit-3 **Multiplexing:** A/D and D/A converters, interfacing with different types of transducers - Analog / Digital, Electrical and non-electrical selection of sensors; Microcomputer interfacing standard buses Serial buses; Serial data communication protocols.

Unit-4 **Study of automatic process control:** Fundamental of automatic process control, building block of automatic system, direct and distributed digital control system. Programmable controllers.

Unit-5 **Personal computer in real life environment:** Introduction, personal computer: system and facility, PC bus and signals, interrupts, interfacing PC with outer world, PC in RTE, Real time application of IBM PC PC based distributed control system

Unit-6 **Programming and application:** Modelling and simulation for plant automation, PLC Architecture and programming of PLC, industrial control application: cement plant, thermal power plant , water treatment plant, steel plant.

Text Books:

1. Kant Krishan. ***Computer based industrial control***. Prentice Hall India Learning Pvt Ltd, New Delhi (2003).

2. Mathivanan N. ***PC-based Instrumentation: Concepts And Practice.***, Prentice Hall India Learning Pvt. Ltd., New Delhi (2007).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Acquire a basic knowledge in Level of automation and economy of computer control.
2. To summarize functional models of I.O. system, interfacing, Sampling.
3. Develop the ability to analyze and design different types of transducers and their interfacing.
4. Observe the direct and distributed digital control system.
5. To inspect real time application of PC based distributed control system and to develop application, Modeling and simulation for plant automation.

		L	T	P	C
EI 335	**Electro-Magnetic Field Theory**				
	B. Tech (Electronics & Instr. Engg.) Professional Core Elective	**3**	**1**	**0**	**4**

Unit-1 **The Static Electric Field:** Coulomb's law, Electric field strength, Field due to point charges, a line charge and sheet charge, field due to a continuous vol. charge, Electric flux density, Gauss's law in integral form, Gauss's law in differential form (Maxwell's first equation in electrostatics), Application of Gauss's law-Electrostatics: potential difference and potential. Potential and potential difference expressed as a line integral. The potential field of a point charge, potential field of a system of charges, conservative property, Potential gradient, the dipole, energy density in the electrostatic field.

Unit-2 **The Static Magnetic Field:** The Biot Savart's law (the magnetic field of filamentary currents), the magnetic field of distributed currents-surface and volume currents, Ampere's circuital law in integral and differential form (Maxwell's curl eqn. for steady magnetic fields), the scalar and vector magnetic potentials-Maxwell's divergence equation for B. Steady magnetic field laws. Forces in a magnetic field, force on a current element. Force between two current elements. Force and torque in a current loop.

Unit-3 **The Electromagnetic Field:** Faraday's laws in integral and differential form (Maxwell's first curl eqn. for electromagnetic field). The Lorentz force equation, the concept of displacement current and modified Ampere's circuital law in integral and differential form. (Maxwell's 2nd curl eqn. for the electromagnetic field)-The continuity equation, Power flow in an electromagnetic field-the Pointing vector. Sinusoidally time varying fields. Maxwell's eqn. for sinusoidally time varying fields. Power and energy considerations for sinusoidally time varying fields, The retarded potentials, Polarization of vector fields. Review of the Maxwell's eqns.

Unit-4 **Materials And Fields (Review Type Only):** Current and current density. The continuity eqn. conductor in fields-drift velocity, mobility, conductivity. Dielectrics in fields-Polarizations, flux density. Electric susceptibility, relative permittivity. Boundary conditions in perfect dielectrics. Magnetic materials, magnetisation, permeability and magnetic boundary conditions.

Unit-5 **Applied Electromagnetics-I:** Poisson's and Laplace's eqns. Solution of one dimensional cases. General solution of Laplace's eqn. Method of images.

Unit-6 **Applied Electromagnetics–II:** Electromagnetic waves, The Helmhottz eqns. Radiation of electromagnetic waves. Wave motion in free pace. Wave motion in perfect dielectric. Wave motion in lossy dielectric. Propagation in good conductors : skin effect. Reflection of uniform plane waves.

Text Books:

1. Kraus John D. ***Electromagnetics***. Tata McGraw-Hill Book Co., New York, (1989).
2. Edminister Joseph A. ***Theory and Problems of Electromagnetics***. ***Schaum's Outline Series***. Tata McGraw Hill Book Company, New York, (1986).
3. William H. Hayt Jr. ***Engineering Electromagnetics***. Tata McGraw-Hill Edition, New Delhi (1998).

Reference Books:

1. Griffith, David J. ***Introduction to Electrodynamic.*** Prentice Hall of India Pvt Ltd., New Delhi (1997).

2. Kraus and Fleish. ***Electromagnetics with Applications***. Tata McGraw–Hill International Editions, United States (1999).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Comprehend the basic concepts of electrodynamics.

2. Represent the physical system in different co-ordinate system.
3. Explain and analyze properties of material.
4. Understand and represent any system in different domain.
5. Apply concepts of Wave reflection and refraction in practical applications and compile technical report.

EI 336	Smart Sensors	L	T	P	C
	B. Tech (Electronics & Instr. Engg.) Professional Core Elective	3	1	0	4

Unit-1 **Basics of Smart Sensors & Micromachining:** Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining, other micromachining techniques.

Unit-2 **Sensor Information to MCU:** Introduction, amplification and signal conditioning, separate versus integrated signal conditioning, digital conversion.

Unit-3 **MCUS and DSPS to Increase Sensor IQ:** Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

Unit-4 **Communications for Smart Sensors :** Introduction, definitions and background, sources and standards, automotive protocols, industrial networks, office & building automation, home automation, protocols in silicon, other aspects of network communications.

Unit-5 **Control Techniques:** Introduction, state machines, fuzzy logic, neural networks, combined fuzzy logic and neural networks, adaptive control, other control areas.

Unit-6 **Sensor Communication & MEMS:** Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Microoptics, microgrippers, microprobes, micromirrors, FEDs.

Unit-7 **Packaging, Testing and Reliability of Smart Sensors:** Introduction, Semiconductor packaging applied to sensors, hybrid packaging, packaging for monolithic sensors, reliability implications, testing smart sensors. UNIT Standards for Smart Sensors: Introduction, setting the standards for smart sensors and systems, IEEE 1451.1, IEEE 1451.2, IEEE P1451.3, IEEE 1451.4, extending the systems to network.

Unit-8 **Implications of Smart Sensor Standards and Recent Trends:** Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

Text Books:

1. Suarez Daniel E. ***Smart Sensors and Sensing Technology.*** Nova Science Publishers, New York (2011).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Develop a strong understanding of sensing and sensor devices, including design, modelling, simulation, and implementation.
2. Select a suitable communication protocol and smart sensor for particular applications.
3. Understand the uses and risks related to sensing technology.
4. Understand, analyze and apply security algorithms for communication network.
5. Apply knowledge of smart sensing as a complete system in engineering applications.

EE 337	**Optimization Techniques**	**L**	**T**	**P**	**C**
	B. Tech (Electronics & Instr. Engg.) Professional Core Elective	**3**	**1**	**0**	**4**

Unit-1 **Introduction to Optimization:** statement of optimization problems, engineering applications-classical optimization techniques-single and multivariable objective function with and without constraints.

Unit-2 **Linear Programming:** Graphical method, Simplex method, Revised simplex method, Duality in linear programming (LP), Sensitivity analysis, other algorithms for solving LP problems, transportation, assignment and other applications.

Unit-3 **Non-linear programming:** one dimensional search, unconstrained optimization tech-gradient approach, steepest descent method, constrained problem- penalty function method, Lagrangian method.

Unit-4 **Dynamic programming:** multistage decision process, principle of optimality, computational procedure in Dynamic programming.

Unit-5 **Further topics in optimization:** Queuing theory, Game theory optimal control theory, calculus of variation, multi-objective optimization, Introduction to genetic algorithm, Case Studies.

Text Books:

1. Kanti Swarup Gupta, P.K and Man Mohan. ***Operation Research***. Sultan Chand publishers, New Delhi (2003).
2. Rao S.S. ***Optimization: Theory and Applications***. Wiley Eastern Ltd New Delhi (2005).
3. Goldberg David E. ***Genetic Algorithms in Search, Optimization & Machine Learning***. Addison Wesley Publishing Company Inc., Boston (1989).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Relate the historical development of operational research (OR) and formulate the design Problems.
2. Apply the linear programming to solve the engineering problems
3. Solve specialized linear programming problems like the transportation and assignment problems
4. Determine the optimum solution to constrained and unconstrained
5. Explain the various concepts of Dynamic Programming and apply the Dynamic Programming techniques to solve the engineering problems and design an optimization

model based on Game theory, Queuing theory and outline the basic concepts of Genetic algorithm.

Open Elective I

EI 381	Air Pollution and Environmental Instrumentation	L T P C
	B. Tech (Electronics & Instrumentation Engg.) **Sixth Semester (Open Elective-I)**	**3 0 0 3**

Unit-1 General introduction to pollution and its classification. Air pollution: its effect on environment, its classification, meteorological factors responsible for pollution, method of sampling and measurement.

Unit-2 Air pollution control methods and equipment: Basics of fluid properties, cleaning of gaseous effluents, particulate emission equipment and control, particulate collector selection and gaseous emission control. Specific gaseous pollutants analysis and control.

Unit-3 Water pollution: Its sources and classification, wastewater sampling and analysis, wastewater treatment. Solid waste management and Hazardous waste management.

Unit-4 Sound pollution: Basics of sound pollution, its effect to environment. Acoustic noise measurement, monitoring and control.

Text Books:

1. Hill Marquita K. ***Understanding Environmental Pollution***. Cambridge University Press, Cambridge (2010).
2. Jeff Kuo. ***Air Pollution Control: Fundamentals and Applications (Fundamentals of Environmental Engineering).*** CRC Press, United States (2018).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Identify air pollution problems and interpret criteria air quality data.
2. Interpret meteorological data and develop capability to assessment of project proposal, air quality.
3. Assess the bacteriological status of water and aquatic systems.
4. Manage solid and hazardous waste and monitoring and controlling of pollution control equipment and their design.
5. Apply suitable instrumentation for wastewater treatment processes and air pollution control for the real-world issues of environmental pollution.

EI 382	Opto-electronics and Fiber Optics	L T P C
	B. Tech (Electronics & Instrumentation Engg.) **Sixth Semester (Open Elective -I)**	**3 0 0 3**

Unit-1 **Optical Fiber:**Introduction, optical fibre, basic principle of fibre-optics, Fiber Materials , Ray Propagation in Step-Index Fibers, Total internal reflection, Ray Propagation in Graded Index Fibers, Mode Theory, Monomode fibers, Attenuation in Optical Fibers – absorption, scattering and bending losses.
Power Launching and Coupling: Source-to- Fiber Power Launching,

Power-coupling calculation, Equilibrium Numerical Aperture, Lensing Schemes for coupling Improvement.

Unit-2 **Fiber-Optic Sensors:** Intensity Modulated Sensors, Phase Modulated Sensors, Fiber-optic Mach-Zehnder Interferometric sensor, Fiber-optic Gyroscope, Spectrally Modulated Sensors, Distributed Fiber Optic Sensors. Optical Amplifiers: Semiconductor Optical amplifiers (SOA), Erbium Doped Fiber amplifiers.

Unit-3 **Optical Sources:** Light Emitting Diodes (LEDs), LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED. LASER diodes: Principle of Operation, Modes and Threshold Conditions, Optical output power and drive current, Quantum efficiency, Resonant frequencies, Radiation Pattern, Single Mode Lasers, Modulation of Laser diode. Laser based instrumentation.

Unit-4 **Optical Detectors:** P-n junction Photo diodes, Power relationship , Responsivity Versus wavelength, Equivalent Circuit of a p-n Photo diode, Bandwidth, p-i-n photo diode and APD, Principle of operation, Sources of noise, Noise Equivalent Circuits , Signal to noise ratio for p-i-n and APD .

Text Books:

1. Keiser Gerd. ***Optical Fiber Communication***. McGraw Hill International Edition. New York (1983)
2. Khare Rajendra P. ***Fiber Optics and Opto electronics***. Oxford University Press. (2004).

Reference Books:

1. Senior, John M. ***Optical Fiber Communications Principles and Practice.*** Pearson Education. London (2014).
2. Sarkar, Chnadan K. and Sarkar, D. C. ***Optoelectronics and Fiber Optics Communication***. New Age International Pvt. Ltd. New Delhi (2012).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the basics of fiber optics in the field of Engineering.
2. Choose different sensors in different aspect of fiber optics.
3. Identify and Analyze various optical sources and detectors along with their properties.
4. Design fibre-optic based system for engineering applications.

EI 383	Digital Image Processing	L T P C
	B. Tech (Electronics & Instrumentation Engg.) **Sixth Semester (Open Elective -I)**	**3 0 0 3**

Unit-1 **Digital Image Fundamentals and Transforms:** Digital image representation, characteristics of digital image, brightness and contrast, elements of perception, image sampling aliasing and quantization, Basic relationship between pixels.

Unit-2 **Two-Dimensional Transforms:** Basic geometric transformations, introduction to 2-dimensional systems and properties, Separable Image Transforms, 2D Fourier Transform, Discrete Cosine Transform, and Wavelet transforms.

Unit-3 **Image Enhancement Techniques:** Spatial Domain methods: Basic grey level transformation, Histogram equalization, Image subtraction, Image averaging, Spatial filtering: Smoothing, sharpening filters, Laplacian filters, Frequency domain filters: Smoothing, Sharpening filters, Homomorphic filtering.

Unit-4 **Image Restoration:** Model of Image Degradation/restoration process, Noise models, Inverse filtering, Wiener filter, least mean square filtering, blind image restoration, Pseudo inverse, Singular value decomposition.

Unit-5 **Image Coding and Compression:** Lossless compression, Variable length coding, LZW coding, bit plane coding, predictive coding, DPCM, Lossy Compression: Transform coding, Wavelet coding, basics of Image compression standards: JPEG, MPEG, Basics of Vector quantization.

Text Books:

1. Gonzalez Rafel C. ***Digital Image Processing I***. Pearson Education. London (2009).

Reference Books:

1. Jain Anil K. ***Fundamentals of Digital Image Processing***. Prentice Hall India Pvt Ltd, New Delhi (1988).
2. Pratt William K. ***Digital Image Processing***. John Wiley & Sons, United States (2007).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and Image-transforms.
2. Choose appropriate technique for image enhancement both in spatial and frequency domains.
3. Identify causes for image degradation and apply restoration techniques.
4. Compare and apply the image compression techniques in spatial and frequency domains.

EI 384	**Wind and Solar based System**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Sixth Semester (Open Elective -I)**	**3 0 0 3**

Unit-1 **Introduction to Energy Sources:** Renewable and non-renewable energy sources, energy consumption as a measure of Nation‟s development, strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources.

Unit-2 **Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells & its applications.

Unit-3 **Wind Energy:** Principle of wind energy conversion, Basic components of wind energy conversion systems, wind mill components, various types and their constructional features, design considerations of horizontal and vertical axis wind machines, analysis of aerodynamic forces acting on wind mill blades and estimation of power output, wind data and site selection considerations.

Text books:

1. G. D. Rai. ***Solar Energy Utilization***, Khanna Publishers. (1995).
2. Sukhatme, Suhas Pandurang. ***Solar Energy -Principles of Thermal Collection and Storage***. Tata McGraw-Hill. New Delhi (2017).
3. Kreith, Frank and Kreider, Jan F. ***Principles of Solar Engineering***. Mc-Graw-Hill Book Co. New York (2000).
4. Manwell, James F.. McGowan, Jon G. and Rogers, Anthony L. ***Wind Energy Explained***. John Weily & Sons Ltd. United States (2002).
5. Abbasi, Shahid Abbas. ***Renewable energy sources and their environmental impact***. Prentice hall of India. New Delhi (2008).

Reference books:

1. Duffie, John A. and Beckmann, William A. ***Solar Engineering of Thermal Processes***. John Wiley. United States (1974).
2. Veziroglu, Turhan. N. ***Alternative Energy Sources***. Vol 5 and 6. McGraw-Hill. New York (2012)
3. Womack, Gerald J. ***MHD power generation engineering aspects.*** Chapman and Hall Publication. United Kingdom (1969).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. To acquire a basic knowledge in Renewable and non-renewable energy to meet the future energy requirements.
2. To explain potential in solar radiation and develop solar cells.
3. To analyze wind potential and design wind power mill.
4. To develop solar and wind power based system.

EI 385	Soft Computing Techniques and Applications	L T P C
	B. Tech (Electronics & Instrumentation Engg.) Sixth Semester (Open Elective -I)	3 0 0 3

Unit-1 **Artificial intelligence systems:** Neural networks, fuzzy logic, genetic algorithms. Artificial neural networks: Biological neural networks, model of an artificial neuron, Activation functions, architectures, characteristics-learning methods, brief history of ANN research-Early ANN architectures (basics only)- McCulloch & Pitts model, Perceptron, ADALINE, MADALINE.

Unit-2 **Back-propagation networks:** architecture, multilayer perceptron, backpropagation learning-input layer, hidden layer, output layer computations, calculation of error, training of ANN, BP algorithm, momentum and learning rate, Selection of various parameters in BP networks. Variations in standard BP algorithms- Adaptive learning rate BP, resilient BP, Levenberg-Marquardt, and conjugate gradient BP algorithms (basic principle only)- Applications of ANN.

Unit-3 **Fuzzy Logic–Crisp & fuzzy sets:** fuzzy relations – fuzzy conditional statements – fuzzy rules – fuzzy algorithm. Fuzzy logic controller – fuzzification interface – knowledge base – decision making logic – defuzzification interface – design of fuzzy logic controller –case studies.

Unit-4 **Genetic algorithms:** basic concepts, encoding, fitness function, reproduction-Roulette wheel, Boltzmann, tournament, rank, and steady state selections, Elitism. Inheritance operators, Cross over different types, Mutation, Bit-wise operators, Generational cycle, Convergence of GA, Applications of GA – case studies. Introduction to genetic programming- basic concepts.

Text books:

1. Vijayalakshmi Pai G. A. and Rajasekaran, Sanguthevar. ***Neural Networks, Fuzzy Logic, and GeneticAlgorithms: Synthesis and Applications***. Prentice Hall of India, New Delhi. (2003).
2. Fausett Laureen. ***Fundamentals of Neural Networks***. Prentice Hall Inc., New Jersey (1994).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Describe and distinguish between human intelligence and AI.
2. Explain how intelligent system works.
3. Discuss the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
4. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems, genetic algorithms to combinatorial optimization problems and neural networks to pattern classification and regression problems.
5. Effectively use modern software tools to solve real problems using a soft computing approach and evaluate various soft computing approaches for a given problem.

EI 386	Wireless Sensor Networks	L T P C
	B. Tech (Electronics & Instrumentation Engg.) Sixth Semester (Open Elective -I)	3 0 0 3

Unit-1 **Characteristics Of WSN:** Characteristic requirements for WSN - Challenges for WSNs – WSN vsAdhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.

Unit-2 **Medium Access Control Protocols:** Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contentionbased protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.

Unit-3 **Routing And Data Gathering Protocols:** Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB.

Unit-4 **Embedded Operating Systems:** Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM.

Unit-5 **Applications Of WSN:** WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.

Text books:

1. Sohraby, Kazem. Minoli Daniel and Znati, Taieb. ***Wireless Sensor Networks Technology, Protocols, and Applications.*** John Wiley & Sons. United States (2007).

2. Karl, Holger and Willig, Andreas. ***Protocols and Architectures for Wireless Sensor Networks.*** John Wiley & Sons, Ltd. United States (2005).

Reference books:

1. Ha´c, Anna. ***Wireless Sensor Network Designs***. John Wiley & Sons Ltd. United states (2003).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Define and list the concepts of overview of sensor technologies and architectures.
2. Design of new technology for sensor networks using MAC and routing layer protocols.
3. Demonstrate and analyse the performance of the routing protocols for Sensor Networks and Infrastructure establishment through the creation of small test beds.
4. Illustrate the operating systems for Wireless sensor networks and inspect the design issue.
5. Outline the applications of Wireless sensor networks and design of new applications for Wireless Sensor Networks

EI 387	**Logic and Distributed Control System**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **Sixth Semester (Open Elective -I)**	**3 0 0 3**

Unit-1 **Review of computers in process control:** Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. alarms, interrupts. Characteristics of digital data, controller software, linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

Unit-2 **Programmable logic controller (PLC) basics:** Definition, overview of PLC systems, input/output modules, power supplies, isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions: PLC Basic Functions: Register basics, timer functions, counter functions.

Unit-3 **PLC intermediate functions:** Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilizing digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance, design of interlocks and alarms using PLC. Creating ladder diagrams from process control descriptions.

Unit-4 **Interface and backplane bus standards for instrumentation systems. Field bus:** Introduction, concept. HART protocol: Method of operation, structure, operating conditions and applications. Smart transmitters, examples, smart valves and smart actuators.

Unit-5 **Distributed control systems (DCS):** Definition, Local Control (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS.

Text books:

1. Webb John W. and Reiss Ronald A. ***Programmable Logic Controllers - Principles and Applications, Third edition.*** Prentice Hall Inc., New Jersey. (1995).
2. Lukcas Michael P. ***Distributed Control Systems.*** Van Nostrand Reinhold Co., New York. (1986).

Reference books:

1. Deshpande P. B. and Ash R. H. ***Elements of Process Control Applications***, ISA Press, NewYork. (1995).
2. Johnson Curtis D. ***Process Control Instrumentation Technology, Fourth edition***. Prentice Hall of India, New Delhi (1996).

Course Outcomes (COs):

At the end of this course, the learner will be able to:

1. Demonstrate the computer based control system techniques.
2. Develop a PLC program for a specific controller.
3. Implement a controller in PLC system and can compile technical report.
4. Understand the architecture and local control unit of Distributed Control System (DCS).
5. Interface various control loops in DCS.

EI 388	**Aerospace & Navigation Instrumentation**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **8th Semester (Open Elective-III)**	**3 0 0 3**

Unit-1 History of aviation and space flight- anatomy of airplane and space vehicle with emphasis on control surfaces- airfoil nomenclature- basics of aerodynamics to illustrate lift and drag- types of drag – finite wings – swept wings –flaps.

Unit-2 Airplane performance- thrust –power- rate of climb absolute and service ceiling- range and endurance. Introduction to turbojet and turbofan engines. Space vehicle trajectories-Kepler’s laws- rocket engines, propellants and staging.

Unit-3 Basic engine instruments- Capacitive fuel content- Gauges. Standard atmosphere- Altimeters Aneroid and radio 6 15% altimeters.

Unit-4 Aircraft compass- Remote indicating magnetic compass Rate of climb indicator- Pitot static system- Air speed indicator- Mach meters- Integrated flight instruments.

Unit-5 GPS and GNSS, - Automatic Pilots- Aircraft flight simulation instrumentation Introduction to guidance, navigation and avionics- Radio navigational aids- automatic direction finder VHF- Phase Comparison direction finder.

Unit-6 Introduction to navigation and guidance instrumentation: Principle, construction and applications of inertial sensors. Gyroscope and accelerometers- Ring laser gyroscope- Fibre optic gyroscope, MEMS gyroscopes and accelerometers.

Text books:

1. Binns Chris. ***Aircraft Systems: Instruments, Communications, Navigation, and Control***, Wiley-Blackwell, New Jersey (2018).
2. Noton Maxwell. ***Spacecraft Navigation and Guidance (Advances in Industrial Control)***, Springer, United Sates (2011).

Course Outcomes (COs):

At the end of this course, the learner will be able to:
1. Explain the history of flight.
2. Illustrate the instrumentation used in an aircraft.
3. Demonstrate how aircraft flies.
4. Demonstrate the navigation system used in aviation and space flight.
5. Design and Simulate Aircraft flight Instrumentation of aerospace system.

Elective II

EI 431	Advanced Instrumentation B. Tech (Electronics & Instrumentation Engg.) Seventh Semester (Professional Core Elective-II)	L T P C 3 1 0 4

Unit-1 Introduction, Instrumentation - Functional elements of an instrumentation system; Sensors & transducers, emerging fields, types of sensors, their parameters. Data acquisition systems-DAS-types-single channel, multi-channel DAS, Digital DAS, applications.

Unit-2 Primary sensing principles and measurement variables, Sensor performance characteristics and terminology.
Transducer measurement circuits, Signal conditioning circuits for strain gauge, LVDT, Piezoelectric sensors, Thermocouples, etc.
Fibre-optic sensors-types, working, applications. Biosensors, their types, working and applications.

Unit-3 Non Destructive Testing - NDT tools - Ultrasonics - Pulse Echo method of Flaw detection - Eddy-current testing - Signature analysis. Gas Chromatography. Nucleonic sensors & their applications.

Unit-4 Intelligent Sensor Systems - Intelligent pressure, Flow, Level, Temperature Sensors, Intelligent sensor application in process control, Complex sensors, biometric sensors, Application of intelligent sensor in biomedical engineering; Microelectronic and micro electro-mechanical systems, applications.

Unit-5 Future scope of intelligent instruments- Structure, definitions and concepts, Smart sensors, Case study: the “electronic nose”, The future of intelligent sensor systems- Multimodal sensors for target recognition, subject tracking, and event understanding.

Text books:

1. Sinclair I. R. ***Sensors and Transducers.*** John Wiley & Sons, United States (2000).

Reference books:

1. Brauer J. R. ***Magnetic Actuators and Sensors.*** Wiley-IEEE Press, United States (2014).
2. Patranabis Dipak. ***Sensors and Transducers.*** Prentice Hall India Learning Pvt Ltd, New Delhi (2013).
3. Barney George C. ***Intelligent instruments.*** Hemel Hempstead: Prentice Hall India Learning Pvt Ltd, New Delhi (1988).
4. Morris Alan S. ***Principles of Measurement & Instrumentation.*** PHI Pvt. Ltd New Delhi (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain Data acquisition systems and working of sensors and transducers.
2. Relate the signal conditioning requirements of different sensors and data acquisition systems.
3. Apply Industrial Non Destructive testing tools.
4. Analyse the working of instrumentation systems for different measurement and intelligent sensing of industrial parameters like flow, pressure, temperature, level etc.
5. Design and develop instrumentation systems for industrial and other requirements.

EI 432	Biomedical Signal Processing B. Tech (Electronics & Instrumentation Engg.) Seventh Semester (Professional Core Elective-II)	L	T	P	C
		3	1	0	4

Unit-1 **Fundamentals of Deterministic Signal:** Data Acquisition, Sampling, aliasing, interpolation, and quantization in time and frequency, spectral analysis. Discrete and continuous random variables, Power spectral density, probability distribution and density functions, Gaussian and Rayleigh density functions, time averages, ensemble averages, autocorrelation functions, cross-correlation functions.

Unit-2 **Adaptive Filters and Algorithms:** A Review of the Wiener filtering problem; Principle of an adaptive filter, Steepest descent algorithm, Windrow-Hoff least mean square adaptive algorithm, inverse Filtering. Least squares and polynomial modelling.

Unit-3 **Noise cancelling:** Principles of Adaptive Noise Cancelling, Adaptive Noise Cancelling with the LMS adaptation Algorithm. Use of blind source separation techniques: principal component analysis (PCA), Independent component analysis (ICA) algorithms for filtering. The Fourier transform, wavelet approximation, discrete wavelet series, discrete wavelet transform (DWT), Multi-resolution analysis, Pyramid algorithm, their use in biomedical signal processing.

Unit-4 **Cardiological Signal Processing:** Introduction to electrocardiography, acquisition, lead system, ECG features and their estimation. Pre-processing, QRS Detection Methods, Rhythm analysis, Arrhythmia detection Algorithms, automated ECG analysis. ECG pattern recognition, Heart rate variability analysis, clinical applications.

Unit-5 **Neurological Signal Processing:** Introduction to brain potential and EEG Signals, its origin, characteristics, frequency division, and evoked potentials. Analysis and detection of spikes and spindles in different frequency bands, Auto Regressive (AR) method for transient detection in case of seizure and sleep stage analysis. Case study: Brain computer interfacing (BCI).

Text books:

1. Rangayyan, Rangaraj M. ***Biomedical Signal Analysis.*** IEEE Press. Canada (2001).
2. D.C.Reddy. ***Biomedical Signal Processing- principles and techniques.*** Tata McGraw-Hill publishers, New Delhi (2007).

3. Tompkins, Willis J. ***Biomedical Digital Signal Processing.*** Prentice Hall India Learning Pvt Ltd, New Delhi (1993).

Reference books:

1. Rolf Weitkunat. ***Digital Bio signal Processing.*** Elsevier, Amsterdam (1991).
2. Metin Akay. ***Biomedical Signal Processing.*** Academic Press, United Staes (2012).
3. Cohen A. ***Biomedical Signal Processing -Vol. I Time & Frequency Analysis.*** CRC Press, Boca Raton (1986).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Acquire knowledge of the fundamentals of deterministic signals
2. Apply the knowledge of different noise cancellation techniques to bio-signals.
3. Apply the knowledge of signal processing to analyze the various events and waveform complexities, and clinical applications of ECG signal
4. Explain the basics of neurological signal and analyze the EEG signal using a parametric method.
5. Get exposed to the case studies and design of Brain computer interfacing (BCI).

EI 433	**Real Time Embedded Systems**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) Seventh Semester (Professional Core Elective-II)	**3 1 0 4**

Unit-1 **Introduction:** Definition, embedded system overview, classifications, Design challenges, processor technology, IC technology and Design Technology and trade-offs. Examples of embedded systems. Typical examples of RTS - characteristics features of real-time-structural, functional and performance requirements of reactive real-time system-distinctive features from non-real-time and off-line systems.

Unit-2 **System Design:** Definition, Classification and brief overview of microcontrollers, microprocessors and DSP‟s. Embedded Processor architecture definitions. Typical application scenarios of embedded systems. Tools: Simulator, in-circuit debugger, in-circuit emulator, programmers, integrated development environment (IDE), cross compilers. Introduction and Architecture of PAL, PLA, CPLD, FPGA, ASIC, PSOC.

Unit-3 **Techniques For Embedded Systems:** State machine and state tables in embedded design, simulation and emulation of embedded systems. High-level language description of S/W for embedded system, Java based embedded system design.

Unit-4 **Modelling Rts:** Event based, Process based and graph based models, petri net models - representation of time concurrency and distributed in discrete event systems-examples of modelling practical systems. Introduction to RTOS, RTOS Scheduling models, interrupt latency and response time - performance metrics.

Unit-5 **Case Studies:** Study of embedded system configurations (involving A/D, D/A, memory and I/O) using MC68HC11, MC8051, ADSP2181 and PIC series of microcontrollers. Interfacing keyboard, displays, ADC, DAC, relay, optoisolator, Frequency counter, Stepper motor control.

Text books:

1. Ball Stuart R. ***Embedded microprocessor Systems: Real world Design.*** Prentice Hall publishers, New York (1996)
2. Herma Kopetz. ***Real Time Systems: Design for distribution embedded applications.*** Kluwer Academic Publishers, New York (1997)
3. Krishna Chandra Mohan. ***Real Time systems.*** Tata Mc-Graw-Hillpublishers, Singapore (1998).
4. Rajkamal. ***Embedded Systems Architecture Programming and Design. Tata*** McGraw Hill, New Delhi (2011).

Reference books:

1. Levi Shem-Tov **and** Agarwala A. K. ***Real- Time System Design.*** Tata Mc-Graw-Hill publisher, NewYork (1990).
2. Laplante Phillip A. ***Real - Time Systems Design and Analysis.*** IEEE Press, NewYork (1992).
3. Bennett Stuart. ***Real-time Computer Control.*** Prentice Hall, London (1998).
4. Gassle Jack. ***Art of Programming Embedded systems.*** Academic Press, United States (1992).

Course Outcomes (COs):

At the end of the course, students are expected to

1. To acquire a basic knowledge about embedded systems, design challenges and processor technology.
2. To classify and compare microcontrollers, microprocessors and DSPs with architectures.
3. Develop simulation and emulation of embedded systems with high-level language.
4. Designing different models for practical systems.
5. Summarise embedded system configurations with different microcontrollers.

EI 434	**IoT based Instrumentation**	**L**	**T**	**P**	**C**
	B. Tech (Electronics & Instrumentation Engg.) **Seventh Semester (Professional Core Elective-II)**	**3**	**1**	**0**	**4**

Unit-1 **Introduction:** Internet of Things Promises – Definition – Scope – Sensors for IoT Applications – Structure of IoT – IoT Map Device.

Unit-2 **Seven Generations Of Iot Sensors To Appear:** Industrial sensors – Description & Characteristics – First Generation – Description & Characteristics – Advanced Generation – Description & Characteristics – Integrated IoT Sensors – Description & Characteristics – Polytronics Systems – Description & Characteristics – Sensors' Swarm – Description & Characteristics – Printed Electronics – Description & Characteristics – IoT

Generation Roadmap.

Unit-3 **Technological Analysis:** Wireless Sensor Structure – Energy Storage Module – Power Management Module – RF Module – Sensing Module.

Unit-4 **Iot Development Examples:** ACOEM Eagle – EnOcean Push Button – NEST Sensor – Ninja Blocks - Focus on Wearable Electronics.

Unit-5 **Preparing Iot Projects:** Creating the sensor project - Preparing Raspberry Pi - Clayster libraries - Hardware-Interacting with the hardware - Interfacing the hardware - Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data - Creating the actuator project - Hardware - Interfacing the hardware - Creating a controller - Representing sensor values - Parsing sensor data - Calculating control states - Creating a camera - Hardware - Accessing the serial port on Raspberry Pi - Interfacing the hardware - Creating persistent default settings - Adding configurable properties - Persisting the settings - Working with the current settings - Initializing the camera.

Text books:

1. Girardin Guillaume, Bonnabel Antoine and Mounier Eric. ***Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 -2024***, Yole Development Copyrights, United States (2014)
2. Peter Waher. ***Learning Internet of Things***. Packt Publishing, United Kingdom (2015)
3. Vermesan, Ovidiu and Friess, Peter. ***Internet of Things – From Research and Innovation to Market.***River publishers, Denmark (2014).
4. Ida, Nathan. ***Sensors, Actuators and Their Interfaces.*** Scitech Publishers, Tamilnadu (2014)

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the basics of IoT based systems.
2. Categorize and analyze the characteristics of different IoT sensors.
3. Develop code for various sensor based applications using wireless sensors.
4. Hands on training on hardware modules commonly used in IoT systems.
5. Design IoT related projects for practical engineering applications.

EI 435	**MEMS & Nanotechnology** **B. Tech (Electronics & Instrumentation Engg.)** **Seventh Semester (Professional Core Elective-II)**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Unit-1 **Introduction:** Micro and nano-scale size domains, Scaling of physical laws, MEMS materials and processes; MEMS devices and applications, Nanostructures in semiconductors and metals, Introduction to quantum effects in nanostructures, Nanostructure applications.

Unit-2 **Fabrication Technologies:** Semiconductor materials, Photolithography, Doping, thin film growth and deposition; metallisation; wet and dry etching; silicon micromachining; metal MEMS processes; nanofabrication methods – submicron optical lithography; electron beam lithography.

Unit-3 **MEMS Sensors and Actuators:** Mechanics including elasticity, Beam bending theory, membranes/plates, microactuators based on various principles e.g. electrothermal, electrostatic, electromagnetic, piezoelectric and SMA; actuator applications e.g. inkjet, electrical and optical switching, physical sensors e.g. acceleration, strain, flow, chemical sensors.

Unit-4 **Microfluidics and Applications of MEMS:** Scaling laws for microfluidics, transport in micro-channels, microfluidic components e.g. filters, mixers/reactors, valves/controllers, pumps. Applications of MEMS in biomedical field, in military field, in atmospheric measurement and other industrial applications.

Unit-5 **Basics of Nanotechnology:** Basics and scale of nanotechnology, different classes of nanomaterials, synthesis of nanomaterials, fabrication and characterization of nanostructures, applications. NEMS basics, synthesis, applications.

Text books:

1. Allen James J. ***Micro electro mechanical system design*****.** CRC press. United States (2005).
2. Maluf Nadim, **and** Kirt Williams. ***Introduction to microelectromechanical systems engineering***. Artech House, United States (2004).
3. Poole Jr, Charles P. **and** Owens Frank J. ***Introduction to nanotechnology*****.** John Wiley & Sons, United States (2003).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the operation of micro devices, micro systems and their applications.
2. Design the micro devices, micro systems using the MEMS fabrication process.
3. Design nano devices and nano systems using preparation methods.
4. Apply the MEMS principles, tools for future directions of micro/nanotechnology.
5. Develop and design micro/nano-scale engineering systems.

EI 436	**Nonlinear Control Systems**	**L**	**T**	**P**	**C**
	B. Tech (Electronics & Instrumentation Engg.) Seventh Semester (Professional Core Elective-II)	**3**	**1**	**0**	**4**

Unit-1 **Linear versus nonlinear systems:** Nonlinear phenomena, multiple equilibria, limit cycles, complex dynamics, manifolds as state space, linearization,methods for nonlinear systems, some classical examples.

Unit-2 **Planar dynamical systems:** Phase plane techniques, limit cycles, Poincare-

Bendixson theorem, multiple equilibria, index theory, bifurcations(fold, pitch, fork, Hopf, saddle connection).

Unit-3 **Mathematical preliminaries:** Ordinary differential equations, control systems, solutions of initial value problems, existence and uniqueness of solutions, continuous dependence on initial conditions and parameters, differential equations with discontinuities, introduction to differential topology.

Unit-4 **Lyapunov stability:** Definitions of (in)stability, basic (in)stability theorems, converse Lyapunov theorems, LaSalle Invariance Principle, exponential stability theorems, linear systems, feedback stabilization.

Unit-5 **Feedback linearization:** SISO systems, input-output linearization, full state linearization, zero dynamics, applications to inversion, tracking and stabilization, MIMO systems, linearization by state feedback, full state linearization, dynamic extension, sliding mode, robust linearization.

Unit-6 **Input-output stability:** Definitions of input-output stability, small gain theorems, passivity, passivity theorems, describing functions, harmonic balance, connections with state space stability.

Unit-7 **Introduction to sliding mode control:** Introduction to Sliding Mode, Classical Sliding Mode Control and Observation.

Text books:

1. Khalil Hassan K. ***Nonlinear Systems.*** Prentice Hall publishing pvt. Ltd., New Jersey (2001).
2. Sastry S. S.. ***Nonlinear Systems: Analysis, Stability and Control.*** Interdisciplinary Applied Mathematics. Springer Verlag, New York (2002).

References:

1. Nijmeijer H. and Schaft A. J. van der. **Nonlinear Dynamical Control Systems**. Springer Verlag, NewYork (1990).
2. A. Isidori. **Nonlinear Control Systems**. Springer Verlag, New York (2013).
3. Eduardo D. Sontag. ***Mathematical control theory: deterministic finite dimensional systems.*** Vol. 6. Springer Science & Business Media (2013).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Analyze the characteristics of nonlinear systems.
2. Demonstrate non-linear system behaviour by phase plane technique and explain functions.
3. Perform the stability analysis of nonlinear systems by Lyapunov method.
4. Show the concept of relative degree and normal forms and apply these notions to feedback linearization and control design.
5. Determine the stability of nonlinear systems.
6. Apply knowledge of non-linear control theory for practical implementations in engineering applications.

EI 437	Linear Integrated Circuits B. Tech (Electronics & Instrumentation Engg.) Seventh Semester (Professional Core Elective-II)	L T P C 3 1 0 4

Unit-1 **Basics Of Operational Amplifiers:** Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations.

Unit-2 **Applications Of Operational Amplifiers:** Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

Unit-3 **Analog Multiplier And PLL:** Analog Multiplier using Emitter Coupled Transistor Pair – Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing.

Unit-4 **Analog To Digital And Digital To Analog Converters:** Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R 2R Ladder types – switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type – Single Slope type – Dual Slope type – A/D Converter using Voltage-to-Time Conversion – Over-sampling A/D Converters.

Unit-5 **Waveform Generators And Special Functions:** Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.

Text books:

1. Choudhry D. Roy and Jain Shail. ***Linear Integrated Circuits***. New Age International Pvt. Ltd., New Delhi (2000).
2. Franco Sergio. ***Design with Operational Amplifiers and Analog Integrated Circuits.*** Tata Mc Graw-Hill publisher, New York (2007).

References:

1. Gayakwad Ramakant A. ***OP-AMP and Linear ICs***. Prentice Hall / Pearson Education, New Delhi (2001).
2. Coughlin Robert F. **and** Driscoll Frederick F. ***Operational Amplifiers and Linear Integrated Circuits***. Sixth Edition, Prentice Hall (2001).
3. Sonde B. S. ***System design using Integrated Circuits.*** New Age Publisher, New Delhi (2001)
4. Gray Paul R., Hurst Paul J., Lewis Stephen H., and Meyer Robert G.. ***Analysis and design of analog integrated circuits*****.** John Wiley & Sons, United States (2009)
5. Jacob Michael. ***Applications and Design with Analog Integrated Circuits***. Prentice Hall of India Learning Pvt Ltd., New Delhi (1996).
6. William D. Stanley. ***Operational Amplifiers with Linear Integrated Circuits***. Pearson Education (2004).
7. Salivahanan S. & Bhaskaran V. S. Kanchana. ***Linear Integrated Circuits.*** TMH, 2008.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the characteristics of OPAMPs.
2. Analyze and design application circuits using OPAMPs.
3. Analyze and design circuits for communication purposes using functional IC’s.
4. Choose appropriate A/D and D/A converters for different applications.
5. Design and choose appropriate functional IC’s for different applications.

Open Elective II

EI 481	Robotics and Automation B. Tech (Electronics and Instrumentation Engg.) Seventh Semester (Open Elective II)	L	T	P	C
		3	0	0	3

Unit-1 **Introduction:** Overview of a robotic system, applications and significance of a robotic system, elements of a robotic system, future advances in robotics.

Unit-2 **Modeling a robotic system:** Introduction to common terms and nomenclature used in robotics- orkspace, joint space, Euler angles, reference systems, robot manipulator – links and joints, DH- parameters, kinematics and dynamics of a two link robot manipulator.

Unit-3 **Actuators:** Electrical actuators- DC motor, stepper motor, drives, servo motor, relays and solenoids. Hydraulic and pneumatic devices- design. Gear trains, limit switches, power supply and hazards.

Unit-4 **Control design:** Basics of a control system – closed loop and open loop, feedback and feed forward control, PID controller. PLC programming and ladder logic, analog input output, microprocessor applications in mechatronics, programming interfacing.

Unit-5 **Case study of robotics system:** Control of a robotic manipulator, underwater vehicle, drone etc.

Text Books:

1. Groover Mikell. ***Industrial Robotics: Technology, Programming, and Applications***. Tata McGraw-Hill, New Delhi (2008).
2. Shetty Devdas and Kolk Richard. ***Mechatronics System Design***. PWS Publishing, (2009).
3. Spong Mark W., Hutchinson Seth and Vidyasagar Mathukumalli. ***Robot Dynamics and Control***. Wiley, New Jersey (2005).

Reference Books:

1. Khatib Oussama. ***Handbook of Robotics***. Springer-Verlag Berlin Heidelberg, New York (2008).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the evolution of robot technology and mathematically model a robot manipulator.
2. Choose appropriate actuators required for a robotic application.
3. Analyse control systems used for a robotic application.
4. Design and model a robotic application for solving real world problem adhering to engineering ethics.

EI 482	Instrumentation in Petrochemical Industry B. Tech (Electronics & Instrumentation Engg.) Eight Semester (Open Elective II)	L	T	P	C
		3	0	0	3

Unit-1 **Petroleum Processing:** Importance of petrochemical industry; Growth in India-Petroleum exploration-Recovery Techniques-Constituents of petroleum-oil-gas separation-Processing wet gases-Refining of crude oil-Refinery gases.

Unit-2 **Chemicals From Petroleum Products:** Chemicals from petroleum - Methane derivatives- Acetylene derivatives- Ethylene derivatives- Propylene derivatives - Cyclic petrochemicals - Other Products.

Unit-3 **Unit Operations In Petrochemical Industry:** Important unit operations-Drying-Separation-Heat transfer-Distillation-Thermal cracking catalytic cracking-catalytic reforming- hydro cracking – hydro treating -Chemical oxidation-Chemical reduction-Polymerisation-Alkylation-Isomerization-Production of Ethylene, Acetylene- and propylene from petroleum.

Unit-4 **Modelling Of Petrochemical Processes:** Modelling of refinery reactors - Dynamic modeling of catalytic cracking unit – catalytic reformer – modeling of crude distillation units – main fractionators.

Unit-5 **Control Loops In Petrochemcial Industry:** Process control in refinery and petrochemical industry-Control of distillation column, catalytic cracking unit, catalytic reformer, pyrolysis unit-Automatic control of polyethylene production-Control of vinyl chloride and PVC production-Optimal control of cracking units and reformers.

Text Books:

1. Balchan, Jens G. and Mumme, Kenneth L. ***Process Control Structures and applications***, Van Nostrand Reinhold Company, New York, 1998.
2. Waddams A.L, ***Chemical from petroleum***, Butter and Janner Ltd., 1968.

Reference Books:

1. Shreeves George T. Austin, ***Chemical Process Industries***, McGraw-Hill International student edition, Singapore, 1985.
2. Liptak, Bela G. ***Instrumentation in process industries***, Chilton book Company, Unites States (1994).
3. Liptak, Bela G. ***Process measurement and analysis***, Third edition, Chilton book Company, United States (1996).

Course Outcomes (COs):

At the end of the course, students are expected to

1. To acquire a basic knowledge about petrochemical industry.
2. To explain different chemicals from petroleum products.
3. To summarize operations involved in petrochemical industry.
4. Designing of models for petrochemical process.
5. Illustrate the control loop in petrochemical industry.

EI 483	Neural Networks and Fuzzy Logic B. Tech (Electronics and Instrumentation Engg.) Seventh Semester (Open Elective II)	L	T	P	C
		3	0	0	3

Unit-1 **Introduction:** Introduction and principles of artificial neuron, activation function, different architectures of neural networks- single layer and multi-layer networks, adaptive resonance theory, applications: The role of neural networks in engineering, artificial intelligence, and cognitive modelling.

Unit-2 **Learning In Neural Networks:** MLP- Back propagation, Gradient-descent learning, Hopefield networks, Kohonen self-organization maps, Schemes of neuro-control, identification and control of dynamical systems, adaptive neuro-controller, case study.

Unit-3 **Fuzzy Logic:** Introduction to fuzzy logic system, fuzzy sets, membership function, linguistic variables, rules and algorithm, fuzzy relations.

Unit-4 **Fuzzy Logic Control System**: Fuzzy logic controller, fuzzification interface, knowledge base, decision making logic, de-fuzzification interface, Inference mechanisms, construction of data base and rule base of FLC design of fuzzy logic controller, case study.

Unit-5 **Neuro – Fuzzy Logic Control:** Optimisation of membership function and rules base of fuzzy logic controller using neural networks, genetic algorithm, fuzzy neuron, adaptive fuzzy systems, case study.

Text Books:

1. Fausett Laurance. ***Fundamentals of Neural Networks***. Prentice Hall, Englewood cliffs, New Jersey (1992).
2. Zimmermann Hans Jurgen. ***Fuzzy set theory and its applications***. Allied Publication Ltd, New York (2001).
3. Klir George J. and Yuan Boe. ***Fuzzy sets and fuzzy logic: Theory and Applications***. Pearson Education India, New Delhi (2015).
4. Driankov Dimiter, Hellendron Hans and Reinfrank Michael. ***An Introduction to Fuzzy control***. Narosa publishing House, New Delhi (1996).
5. Thomas Millon, Richard Sutton and Webrose Paul. ***Neural Networks for control***. MIT Press, United States (1995).

Reference Books:

1. Tsoukalas Lefteri H, Uhrig Robert E and Zadeh Lotfi A. ***Fuzzy and Neural approach in Engineering***. John Wiley and Sons, United States (1997).
2. Zurada Jacelk. ***Introduction to artificial Neural Systems***. Jaico Publishing House, Mumbai, (1994).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Comprehend the concepts of neural networks.
2. Explain and represent the neural network.
3. Develop fuzzy logic for a system.
4. Apply knowledge of fuzzy logic for practical implementations in engineering applications.
5. Analysis and Interface of neuro and fuzzy logic control.

EI 484	**Renewable Energy Systems** **B. Tech (Electronics and Instrumentation Engg.)** **Seventh Semester (Open Elective II)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Unit-1 **Overview:** Classification of Energy Sources; Advantages of renewable energy sources, Impact on environment and economy; overview of electricity generation from various renewable energy sources (solar, wind, tidal, geothermal, etc.

Unit-2 **Solar Energy Systems:** Electricity generation from solar energy; Principle of energy conversion in Solar Photovoltaic cells; I-V, P-V Characteristics; modelling of PV cell/system; Maximum power point tracking. Thermal Energy Generation from Solar Energy; Solar Collector; Solar Energy use for water heating.

Unit-3 **Wind Energy Systems:** Electricity Generation from Wind Energy: Wind as energy source, Selection of site for Wind farm, characteristics of different types of wind generators used with wind turbines; Maximum power point.

Unit-4 **Energy Storage:** Introduction to various energy storage systems; battery storage; supercapacitor storage; fuel cell, etc. Modelling; charging discharging control.

Unit-5 **Case Study:** Simulation of a single or hybrid renewable energy system.

Text Books:

1. Bansal Kleeman and Melisa. ***Renewable Energy Sources & Conversion Technology***. Tata McGraw Hill, New Delhi (1990).
2. Khan Badrul H. ***Renewable Energy Sources***. McGraw Hill Education India Private Limited, New Delhi (2017).

Reference Books:

1. Tarascon Jean-Marie and Simon Patrice. ***Electrochemical Energy Storage***. Wiley, United States (2015).
2. Moseley Patrick T. and Garche Jürgen. ***Electrochemical Energy Storage for Renewable Sources and Grid Balancing***. Elsevier, United States (2014).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the primary renewable energy resources and technologies.
2. Evaluate different energy technologies based on efficiency, impacts and other factors.
3. Compare various renewable energy technologies and propose the best possible energy conversion system for a particular application.
4. Model and implement different types of energy storage devices.

5. Apply knowledge of different renewable energy system in engineering applications.

EI 485	Machine Learning B. Tech (Electronics and Instrumentation Engg.) Seventh Semester (Open Elective II)	L	T	P	C
		3	0	0	3

Unit-1 **Introduction:** what is Machine learning, Problems, data, and tools, Visualization, Linear regression, SSE, gradient descent, closed form, normal equations; features, Overfitting and complexity; training, validation, test data, and introduction to Matlab.

Unit-2 **Classification problems**: decision boundaries, nearest neighbor methods,Probability and classification, Bayes optimal decisions,Naive Bayes and Gaussian class-conditional distribution, Linear classifiers, Bayes' Rule and Naive Bayes Model,Decision tree, Ensemble methods: Bagging, random forests, boosting, A more detailed discussion on Decision Tree and Boosting.

Unit-3 **Unsupervised learning:** clustering, k-means, hierarchical agglomeration, Advanced discussion on clustering and EM, Latent space methods; PCA, Text representations; naive Bayes and multinomial models; clustering and latent space models.

Unit-4 **VC-dimension:** structural risk minimization; margin methods and support vector machines (SVM), Support vector machines and large-margin classifiers,Time series; Markov models; autoregressive models.

Text Books:

1. Ethem Alpaydin. ***Introduction to Machine Learning***, Second Edition. MIT Press, United States. (2004).
2. Marsland Stephen. ***Machine Learning: An Algorithmic Perspective***. CRC Press, United States. (2009).
3. Bishop Christopher M. ***Pattern Recognition and Machine Learning.*** Springer, United States. (2006).

Reference Books:

1. Mitchell Tom M. ***Machine Learning.*** McGraw Hill, New York (1986).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the fundamentals of machine learning
2. Distinguish various learning approaches, and to interpret the concepts of supervised learning.
3. Apply theoretical foundations of decision trees to identify best split and Bayesian classifier to label data points.
4. Illustrate the unsupervised learning techniques, the algorithm used for data clustering and identify its applicability in real life problems.

5. Demonstrate the working of classifier models like SVM, large-margin and identify classifier model for typical machine learning applications.

EI 486	**Probability and Random Processes** **B. Tech (Electronics and Instrumentation Engg.)** **Seventh Semester (Open Elective II)**	**L T P C** **3 0 0 3**

Unit-1 **Introduction to Probability:** Definitions, scope and history; limitation of classical and relative-frequency-based definitions- Sets, fields, sample space and events; axiomatic definition of probability, Combinatorics: Probability on finite sample spaces, Joint and conditional probabilities, independence, total probability; Bayes' rule and applications.

Unit-2 **Random variables:** Definition of random variables, continuous and discrete random variables, cumulative distribution function (cdf) for discrete and continuous random variables; probability mass function (pmf); probability density functions (pdf) and properties; Jointly distributed random variables, conditional and joint density and distribution functions, independence; Bayes' rule for continuous and mixed random variables; Function of one random variable, pdf of the function of a random variable; Function of two random variables; Sum of two independent random variables; Expectation: mean, variance and moments of a random variable; Joint moments, conditional expectation; covariance and correlation; independent, uncorrelated and orthogonal random variables; Random vector: mean vector, covariance matrix and properties; Some special distributions: Uniform, Gaussian and Rayleigh distributions; Binomial, and Poisson distributions; Multivariate Gaussian distribution; Vector-space representation of random variables, linear independence, inner product, Schwarz Inequality; Elements of estimation theory: linear minimum mean-square error and orthogonality principle in estimation; Moment-generating and characteristic functions and their applications.

Unit-3 **Sequence of random variables and convergence:** Almost sure (a.s.) convergence and strong law of large numbers; convergence in mean square sense with examples from parameter estimation; convergence in probability with examples; convergence in distribution; Central limit theorem and its significance.

Unit-4 **Random Process:** Random process: realizations, sample paths, discrete and continuous time processes, examples; Probabilistic structure of a random process; mean, autocorrelation and auto-covariance functions; Stationarity: strict-sense stationary (SSS) and wide-sense stationary (WSS) processes; Autocorrelation function of a real WSS process and its properties, cross-correlation function; Ergodicity and its importance; examples of random processes: white noise process and white noise sequence; Gaussian process; Poisson process, Markov Process.

Text Books:

1. Papoulis Athanasios and Pillai S. Unnikrishnan. ***Probability, Random Variables, and Stochastic Processes.*** McGraw Hill, New York (2001).

REFERENCE BOOKS:

1. Gallager Robert G. ***Stochastic processes: theory for applications.*** Cambridge University Press. Cambridge (2013).
2. H. Kobayashi, B.L. Mark, and W. Turin. ***Probability, Random Processes, and Statistical Analysis.*** Cambridge University Press. United States (2012).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Acquire knowledge about Probability and Random variables, distribution.
2. Analyse random phenomena using various models of probability distributions and random processes.
3. Explain the concepts of various stationary processes and appreciate their significance.
4. Implement the concepts of various correlations and power spectral density in the analysis of random signals.

		L	T	P	C
EI 487	**Human Computer Interfaces** **B. Tech (Electronics and Instrumentation Engg.)** **Seventh Semester (Open Elective II)**	**3**	**0**	**0**	**3**

Unit-1 **Introduction:** Importance of user Interface – Definition, Importance of good design, Benefits of good design, A brief history of Screen design.

Unit-2 **The graphical user interface**::Popularity of graphics, The concept of direct manipulation, Graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.

Unit-3 **Design process:** Human interaction with computers, Importance of human characteristics human consideration, Human interaction speeds, Understanding business junctions.

Unit-4 **Screen Designing:** Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

Unit-5 **Windows:** New and Navigation schemes selection of window, selection of devices based and screen based controls. Components: Text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.
Software tools: Specification methods, interface – Building Tools. Interaction Devices: Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers- BCI and its applications.

Text Books:

1. Galitz Wilbert O. ***The essential guide to user interface design***. Wiley DreamTech. United States (1997).
2. Shneidermann Ben. ***Designing the user interface***. 3rd Edition, Pearson Education, Asia.

(1998).

Reference Books:

1. Alan Dix, Janet Fincay, Gre Goryd, Abowd and Russell Bealg. ***Human – Computer Interaction.*** Pearson Education, London (1993).
2. Jenni Preece, Helen Sharp & Yvonne Rogers. ***Interaction Design: Beyond Human Computer Interaction.*** Wiley, United States (2015).
3. Soren Lauesen. ***User Interface Design***. Pearson Education, London (2004).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Acquire knowledge of human computer interfacing techniques.
2. Understand interaction and manipulation through user inputs.
3. Explain basic principles and techniques in and required modern modification.
4. Analyze the characteristics of presentation of information.
5. Design and Develop multi-device interface for Human Computer Interfacing applications.

EI 488	**Mobile Adhoc and Sensor Networks**	**L**	**T**	**P**	**C**
	B. Tech (Electronics and Instrumentation Engg.)				
	Seventh Semester (Open Elective II)	**3**	**0**	**0**	**3**

Unit-1 **Introduction:** Adhoc networks. Mobile Ad-Hoc networking with a View of 4G Wireless, Off-the-Shelf Enables of Ad Hoc, IEEE 802.11 in Ad Hoc Networks.

Unit-2 **Protocols, Performance and Open Issues:** Scatternet Formation in Bluetooth Networks, Antenna Beam forming and Power Control for Ad Hoc Networks, Topology Control in Wireless Ad Hoc Networks, Broadcasting and Activity Scheduling in Ad Hoc Networks.

Unit-3 **Location Discovery:** Routing Approaches in Mobile Ad Hoc Networks, Energy-Efficient Communication in Ad Hoc Wireless, Ad Hoc Networks Security, Self-Organized and Cooperative Ad Hoc Networking.

Unit-4 **Simulation and Modeling of Wireless, Mobile, and Ad Hoc Networks:** Modeling Cross-Layering Interaction Using Inverse Optimization Algorithmic Challenges in Ad Hoc Networks.

Unit-5 **Sensor Networks:** Introduction to sensor network, Unique constraints and challenges, Localization and Tracking, Networking Sensors, Infrastructure establishment, Sensor Tasking and Control, Sensor network databases, Sensor Network Platforms and tools, Industrial Applications and Research directions.

Text Books:

1. Aggelou George**.** ***Mobile Adhoc Networks***, McGraw-Hill, United States (2004).
2. Basagni Stefano. Conti Marco. Giordano Silvia. Stojmenovi Ivan and Cacute. ***Mobile Adhoc Networking.*** Wiley-IEEE Press, United States (2004).

Reference Books:

1. Zhao Feng and Guibas Leonidas. ***Wireless Sensor Networks: An Information Processing Approach.*** Elsevier. United States (2004).
2. Stojmenovic Ivan and Cacute. ***Handbook of Sensor Networks: Algorithms and Architectures***. Wiley. New Jersey (2005)

Course Outcomes (COs):

At the end of the course, students are expected to
1. Understand routing Approaches in Mobile Ad Hoc Networks.
2. Analyze energy management in mobile adhoc and sensor network.
3. Implement basic principles and techniques in designing mobile adhoc and sensor network.
4. Apply knowledge of sensor networks and mobile ad hoc networks for practical implementations in engineering applications.

EI 489	**Aquaponics Monitoring and Control** **B. Tech (Electronics and Instrumentation Engg.)** **Seventh Semester (Open Elective II)**	**L** **3**	**T** **0**	**P** **0**	**C** **3**

Unit-1 **Introduction:** Current global food production systems and the need for sustainable farming. An overview of aquaponics system components, sys- tem types and an exploration of the versatility of aquaponics. The Aquapon- ics cycle. Advantages, limitations and disadvantages of aquaponics systems.

Unit-2 **Pond and fish management:** The nitrogen cycle and nutrient flows. pH and alkalinity, other parameters and water quality. Anatomy, life cycles and reproductive strategies of fish. Species profiles of some suitable aquaponics fish. Prevention, recognition and treatment of fish health parasites and pathogens. Calculating stocking densities and feed rates.

Unit-3 **Plant management:** Anatomy, life cycles and reproductive strategies of plants. Species profiles of some suitable aquaponics crops. Nutritional requirements of plants. Prevention recognition and treatment of plant parasites and pathogens.

Unit-4 **Control parameters of aquaponics system:** Sensors for Water levels, Temperature, pH, Humidity, Light, Oxygen, Nitrogen and Ammonia contents in water, E.coil levels, Fish feed set point.

Unit-5 **Automation in aquaponics:** Need of control in aquaponics system, Differ- ent types of control schemes: Cascade control scheme, Distributed control scheme, Model predictive control scheme. Practical implementation and human machine interface.

Text Books:

1. Dale Seborg, Edgar Thomas and Mellichamp Duncan. ***Process Dynamics and Control.***

Wiley, New Jersey. (2003).
2. Zhang Qin and Pierce Francis J. ***Agricultural automation: fundamentals and practices.*** CRC Press, United States(2016).
3. Spedding Colin. ***An introduction to agricultural systems***. Springer Science & Business Media, Berlin (2012).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the fundamentals of what aquaponics gardening entails.
2. Ability to design and size aquaponics system.
3. Understand the dietary and environmental needs of potential fish species.
4. Know the limits of various biological and chemical parameters to monitor and control for optimum operation of aquaponics system.
5. Be cognizant of the various sensors and actuators required to ensure a fully functioning aquaponics system.

Elective III

EI 441	**Advanced Sensors and Signal Processing** **B. Tech. (Electronics and Instrumentation Engg.)** **Eighth Semester (Professional Core Elective-III)**	**L T P C** **3 1 0 4**

Unit-1 **Review of sensors and transducers**-classifications--Input and output characteristics of various transducers, variable resistance transducer, variable inductance and variable capacitance transducers, their construction and performance, Piezoelectric transducer.

Unit-2 **Design techniques for sensor signal conditioning:** Sensor and signal conditioning for strain, force, pressure, flow and temperature measurement, Bridge configurations, Amplifying and linearizing bridge outputs, Driving bridge circuits. Ratiometric techniques.

Unit-3 **High impedance sensors:** Photodiodes and high impedance charge output sensors, Signal conditioning of high impedance sensors.

Unit-4 **Positioning, motion and temperature sensors:** LVDT, Hall effect magnetic sensors, optical encoders Accelerometer, RTDs, thermistors, thermocouples, semiconductors temperature sensors and their signal conditioning.

Unit-5 **Micro-sensors and smart sensors:** Construction, characteristics, and applications.

Unit-6 **Hardware design techniques:** Grounding in mixed signal systems, Power supply noise reduction and filtering, Shielding and isolation technique, Over-voltage and Electrostatic discharge (ESD) protection techniques.

Text Books:

1. Neubert, Hermann K.P. ***Instrument Transducers***. Oxford University Press, London (2008).
2. Areny, Ramon Pallas and Webster, Johan G. ***Sensor and Signal Conditioning.***John Wiley, New York (1991).
3. Dan Sheingold. ***Transducer Interfacing Handbook***, Analog Devices Inc. , United States (1980).
4. Kester, Walt. ***High Speed Design Technique.*** Analog Device Inc. United Sates (1996)
5. Fraden, Jacoba. "***Handbook Of Modern Sensors*** 2nd Edition. Springer-Verlag. New York (1996)
6. Graeme, Jerald G. ***Photodiode Amplifiers And Op-Amp Solution***, Tata Mc Graw Hill Publisher, New York (1995)
7. Trietly, Harry L. ***Transducers in Mechanical and Electronic Design***, Marcel Dekker Inc. New York (1986).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the basic principles of different sensors.
2. Develop signal conditioning techniques for various sensors.
3. Select the appropriate sensor to perform engineering tasks and scientific researches.
4. Understand the basics of micro and smart sensors.

5. Apply knowledge of advanced sensing techniques in the design of sensors.

EI 442	Piping and Instrumentation B. Tech. (Electronics and Instrumentation Engg.) Eighth Semester(Professional Core Elective-III)	L	T	P	C
		3	1	0	4

Unit-1 **Introduction-** Significance of piping- Industry oriented piping-P&I Diagram objectives. Industry Codes andStandards. Government regulations.

Unit-2 **Piping basics and fundamentals :** Introduction to piping, Evolution of piping, Manufacturing methods, Pipingmaterials and selection, Pipe dimensioning, Schedule numbers, Common piping abbreviations, Major organizations for standards, Commonly American code in piping ASME/ANSI, Common abbreviations.

Unit-3 **Piping components:** Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socketwelded fittings, Pipe nipples, flanged fittings and use of fittings. Flange -Types, P-T ratings and facings. Gaskets, bolts and nuts. Valves -Types, operations, applicability, codes and specifications.

Unit-4 **Process plant equipment/mechanical equipment:** Horizontal vessels/accumulators, fractionation columns,pumps, heat exchangers, re-boiler, air cooled heat exchanger, cooling towers, heaters/boilers, storage tanks, fractional distillation process and vendor data drawings.

Unit-5 **Flow diagrams& instrumentation/ pipe routing concepts:** Uses of flow diagrams, process flow diagrams,mechanical flow diagrams, utility flow diagrams, piping symbols, line symbols, valve symbols, piping isometrics, general arrangement drawings- sections/elevations/ detail drawings, plot plan procedures, Electrical Diagrams, Electronic diagrams, Logic diagrams. DCS diagrams, Construction diagrams. Format. Equipment. Instrumentation and Controls. Applications of P&I diagrams in HAZOPS and Risk analysis.

Unit-6 **Process & instrumentation diagrams (P&ID)/ process flow diagram (PFD) :** Purpose ofP&ID"S, study ofP&ID"S, stages of development of P&ID"S, process and instrumentation diagrams, process equipments, symbols usage according to industrial practices. Purpose of P&ID in process industrial/plants.

Unit-7 **ASME/ANSI codes and specifications:** ASME/ANSI Codes & Specification, Specification classes, Piping abbreviations, General abbreviations.

Unit-8 **Equipment layout drawings:** Plant Co-ordinate Systems, Site Plans, UNIT Plot Plan, Equipment LocationDrawing, Foundation Location Drawing.

Reference Books:

1. Toghraei Moe. ***Piping and Instrumentation Diagram Development.*** Wiley-Blackwell Publishers, United States (2019).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Acquire knowledge of piping industry and modern advancements.
2. Identify and discuss piping components and its installation.
3. Implement flow diagrams and pipe routing schemes.
4. Apply knowledge of Standard piping system in plants.
5. Develop process & instrumentation diagrams (P&ID)/ process flow diagram (PFD).

EI 443	Industrial Automation B. Tech. (Electronics and Instrumentation Engg.) Eighth Semester (Professional Core Elective-III)	L	T	P	C
		3	1	0	4

Unit-1 **Control Systems and Automation Strategy:** Evolution of instrumentation and control, Role of automation in industries, Benefits of automation, Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC, Automation strategy evolution, Control system audit, performance criteria, Safety Systems.

Unit-2 **Programmable logic controllers (PLC):** Introduction, architecture, definition of discrete state process control, PLC Vs PC, PLC Vs DCS, relay diagram, ladder diagram, ladder diagram examples, relay sequencers, timers/counters, PLC design, Study of industrial PLC.

Unit-3 **Advance Applications of PLC and SCADA:** PLC programming methods as per IEC 61131, PLC applications for batch process using SFC, Analog Control using PLC, PLC interface to SCADA/DCS using communication links (RS232, RS485) and protocols (Modbus ASCII/RTU).

Unit-4 **Instrumentation Standard Protocols:** HART Protocol introduction, frame structure, programming, implementation examples, Benefits, Advantages and Limitations. Foundation Fieldbus H1 introduction, structure, programming, FDS configuration, implementation examples, Benefits, Advantages and Limitations, Comparison with other fieldbus standards including Device net, Profibus, Controlnet, CAN, Industrial Ethernet etc.

Unit-5 **Distributed Control Systems**: DCS introduction, functions, advantages and limitations, DCS as an automation tool to support Enterprise Resources Planning, DCS Architecture of different makes, specifications, configuration and programming, functions including database management, reporting, alarm management, communication, third party interface, control, display etc. Enhanced functions viz. Advance Process Control, Batch application, Historical Data Management, OPC support, Security and Access Control etc.

Unit-6 **Automation for following industries** – Power, Water and Waste Water Treatment, Food and Beverages, Cement, Pharmaceuticals, Automobile and Building Automation.

Text Books:

1. Bhatkar Poppovik. ***Distributed Computer Control for Industrial Automation.*** Marcel Dekkar Publications, New York (1990).
2. Reis Ronald A, Webb John W. ***Programmable Logic Controllers: Principles and Applications.*** Prentice Hall India Learning Pvt Ltd., New Delhi (2002).
3. Singh S.K. ***Computer Aided Process Control.*** Prentice Hall India Learning Pvt Ltd, New Delhi (2004)

Reference Books:

1. Dunning Garry. ***Introduction to Programmable Logic Controllers.*** Thomson Learning,New York (2005).
2. Battikha N.E. ***The Management of Control System: Justification and Technical Auditing.*** ISA, United States (1992).
3. Kant Krishna. ***Computer Based Process Control***. Prentice Hall India Learning Pvt Ltd., New Delhi, (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Acquire knowledge of control systems and automation strategy.
2. Understand and implement PLC architecture and ladder logic
3. Develop SCADA model for a process and interface with PLC.
4. Identify communication protocol for an industrial process.
5. Develop automation strategy for an automation plant.

EI 444	**Wireless Communication** **B. Tech. (Electronics and Instrumentation Engg.)** **Eighth Semester (Professional Core Elective-III)**	**L T P C** **3 1 0 4**

Unit-1 **Introduction to Wireless Communication Systems**: Evolution of mobile radio communications, examples of wireless comm. systems, paging systems, Cordless telephone systems, comparison of various wireless systems.

Unit-2 **Modern Wireless Communication Systems:** Second generation cellular networks, Third generation cellular networks, Fourth generation cellular network, wireless in local loop, wireless local area networks, Blue tooth and Personal Area networks.

Unit-3 **Cellular System Design Fundamentals:** Frequency Reuse, Spectrum Allocation, channel assignment strategies, handoff Strategies, Interference and system capacity, Trunking and grade off service, improving coverage and capacity in cellular system.

Unit-4 **Mobile Radio Propagation: Large Scale Path Loss:** Introduction to radio wave propagation, free-space propagation model, basic propagation schemes, pathloss model, outdoor propagation model-Okamura and Hata Model.

Unit-5 **Mobile Radio Propagation:** Small Scale Fading and multipath: Factors influencing small scale fading, Doppler Shift, impulse response model of a multipath channel, parameters of mobile multipath channel-time dispersion, coherence bandwidth, doppler spread, coherence time, types of small scale fading, rayleigh and rician distribution.

Unit-6 **Multiple Access Techniques** for Wireless Communication Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access, packet ratio, capacity of a cellular systems.

Unit-7 **Intelligent Cell Concept and Application:** Intelligent cell concept, applications of intelligent micro-cell Systems, in-Building Communication, CDMA cellular Radio Networks.

Text Books:

1. Rappaport Theodore S. ***Wireless Communications.*** Pearsons Education India, New Delhi (2010).
2. Lee William C.Y. ***Mobile Cellular Telecommunication.*** McGraw Hill, New York (1995).

Reference Books:

1. Schiller Jochen. ***Mobile Communications.*** Pearson Education Ltd., London (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the cellular system design and technical challenges.
2. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modelling.
3. Analyze Multiuser Systems, CDMA, WCDMA network planning Concepts.
4. Apply knowledge of wireless communication for practical implementations in engineering applications.

EI 445	Adaptive Control	L T P C
	B. Tech. (Electronics and Instrumentation Engg.)	
	Eighth Semester (Professional Core Elective-III)	3 1 0 4

Unit-1 **Overview:** Overview of Adaptive Control Systems. Direct and indirect adaptive control. The principle of certainty-equivalence.

Unit-2 **Advanced tools for stability of non-autonomous nonlinear systems:** Definitions. Converse Lyapunov theorems. LaSalle/Yoshizawa theorem. Passivity theory. Zero-state detectability. Positive real and strictly positive real transfer functions. Kalman-Yakubovich-Popov lemma.

Unit-3 **Stability of prototypical adaptive control systems:** The role of the persistency of excitation condition. Uniform observability. Exponential convergence vs. exponential stability and uniform asymptotic stability.

Unit-4 **Adaptive observers for linear systems:** Systems in adaptive observer form. Filtered transformations.

Unit-5 **Model reference adaptive control:** Paramterization of the certainty-equivalence controller. MRAC schemes for linear systems with relative degree one and two. Uniform global asymptotic stability of MRACs: uniform persistency of excitation condition.

Unit-6 Adaptive controllers for nonlinear systems. Adaptive back stepping. Design with over parameterization. Tuning functions method. Output-feedback design.

Unit-7 Geometric theory of adaptive systems. Invariant manifold techniques. Slow adaptation. Two-time scales and averaging.

Unit-8 Robust redesign of adaptive control systems. Robustness of adaptive systems. Dead-zone and projection-based techniques.

Unit-9 Selected topics. The adaptive regulator problem. Adaptive internal model design.

Text Books:

1. Ioannou, Petros and Fidan, Baris. ***Adaptive Control Tutorial***, SIAM, United States (2006).
2. Narendra, K. S. and Annaswamy A. M.. ***Stable Adaptive System.*** Prentice-Hall India Learning Pvt Ltd, New Delhi (1989)
3. Sastry, Shankar and Bodson, Marc. ***Adaptive Control.*** Prentice Hall India Learning Pvt Ltd, New Delhi (1989).
4. Isidori, Marconi Lorentz and Serrani, Andrea.. ***Robust Autonomous Guidance. An Internal Model Approach.*** Springer-Verlag (2003).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Formulate adaptive control design problem
2. Perform stability analysis of non-autonomous nonlinear systems
3. Identify suitable adaptive controller for a given system with uncertain parameters
4. Design adaptive controller and observer to meet the performance objectives
5. Apply adaptive design techniques to real-time systems whose parameters change during operation.

		L	T	P	C
EI 446	**Analog Integrated Circuit Design** **B. Tech. (Electronics and Instrumentation Engg.)** **Eighth Semester (Professional Core Elective-III)**	**3**	**1**	**0**	**4**

Unit-1 **Introduction:** Introduction to Analog IC Design, Analog IC Design flow. MOSFET basics, Single stage MOS amplifiers – CS, CG, Source follower, frequency response.

Unit-2 **Current mirrors:** Biasing and references, Constant voltage and current references, Voltage regulator.

Unit-3 **CMOS Differential pair:** Two-stage CMOS Op-amp and compensation, Telescopic and Folded cascode Op-amp, Fully differential op-amp, Common-mode feedback, Noise and linearity analysis, Dynamic range.

Unit-4 **CMOS comparator:** Basics of Switched capacitor circuits, Voltage controlled oscillator (VCO), Phase locked loop (PLL).

Text Books:

1. P.E. Allen and D.R.Holberg. ***CMOS Analog Circuit Design.*** Oxford University Press (2004)
2. R.J.Baker, H. W. Li, D. E. Boyce. ***CMOS Circuit Design, Layout, and Simulation.*** PHI (2002).
3. P.R.Gray, P.J.Hurst, S.H.Lewis and R.G.Meye. ***Analysis and Design of Analog Integrated Circuits.*** John Wiley & Sons, Fourth Edition (2003).

Reference Books:

1. R. L. Geiger, P. E. Allen and N. R. Strader. ***VLSI Design Techniques for Analog and Digital Circuits.*** McGraw-Hill (1990).
2. D.A. Johns and K. Martin. ***Analog Integrated Circuit Design.*** John Wiley and Sons (2004).
3. B. Raza. ***Design of Analog CMOS Integrated Circuits.*** Tata McGraw-Hill (2002).
4. Sedra and Smith. ***Microelectronics Circuits***, 5th Edition, International Student Edition, Oxford University Press, New Delhi.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Design analog IC.
2. Design and analyze the basic operations of MOSFET.
3. Develop and analyze CMOS and Op-amp based differential circuits.
4. Implement comparator, oscillator and switching circuits.

EI 447	Mechatronics B. Tech. (Electronics and Instrumentation Engg.) Eighth Semester (Professional Core Elective-III)	L	T	P	C
		3	1	0	4

Unit-1 Introduction: overview of a mechatronic system, applications and significance of a mechatronics system, elements of a mechatronics system, future advances in mechatronics system.

Unit-2 Modelling a robotic system: introduction to common terms and nomenclature used in robotics industry- workspace, joint space, Euler angles, reference systems, robot manipulator – links and joints, DH- parameters, kinematics and dynamics of a two link robot manipulator.

Unit-3 Sensors and Transducers: tachometers, proximity and range sensors, accelerometers, gyroscopes, SONAR and RADAR, vision sensor, encoders and resolvers.

Unit-4 Actuators: electrical actuators-DC motor, stepper motor, drives, servo motor, relays and solenoids. Hydraulic and pneumatic devices- design. Gear trains, limit switches, power supply and hazards.

Unit-5 Control design: basics of a control system – closed loop and open loop

Unit-6 Case study of mechatronic systems: homing of an industrial robot in a remote location using image processing.

Text Books:

1. Groover Mikell. ***Industrial Robotics: Technology, Programming, and Applications.*** 2nd edition, Tata McGraw-Hill, New York (2010)
2. Shetty Devdas and Richard Kolk. ***Mechatronics System Design.*** 3rd edition. PWS Publishing, United states (2009).
3. Spong Mark W., Hutchinson Seth, and Vidyasagar **Mathukumalli**. ***Robot Dynamics and Control.***, Wiley, New York (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the basics of Mechatronics System with applications, significance & future advances.
2. Learn the techniques, skills to model a robotic system
3. Identify sensors, transducers and actuators to monitor and control the behaviour of a process or product.
4. Analyze the characteristics of a control system necessary for mechatronics.
5. Apply knowledge of mechatronics system to implement of an industrial robot in a remote location using image processing.

Open Elective III

EI 490	Intelligent Instrumentation B. Tech (Electronics & Instrumentation Engg.) 8th Semester(Open Elective-III)	L T P C 3 0 0 3

Unit-1 **Introduction:** Introduction: Intelligence, features characterizing intelligence, intelligent instrumentation system; features of intelligent instrumentation; components of intelligent instrumentation system. Block diagram of an intelligent instrumentation system.

Unit-2 **Data Acquisition Methods:** Data acquisition systems-DAS-types-single channel, multi-channel DAS, Digital DAS, applications. Interfacing methods of DAQ hardware, software structure, use of simple and intermediate Virtual Instruments (VIs). Use of data sockets for networked communication and controls. Data Acquisition with LabVIEW DAQmx and DAQ Vis: Measurement and automation explorer, the waveform data type, working in DAQmx, interfacing with Assistants: DAQ assistant, Analysis assistant, Instrument assistant.

Unit-3 **Smart Sensors: Intelligent Sensors:** Introduction, Classification, Smart Sensors, Cogent Sensors, Soft or Virtual Sensors, Self-Adaptive Sensors, Self-Validating Sensors, VLSI Sensors, Temperature Compensating Intelligent Sensors. Film sensors (Thick film sensors, this film sensor), MEMS and Nano-Sensors.

Unit-4 **Interfacing Instruments:** GPIB and RS232: RS232C versus GPIB, handshaking, GPIB interfacing, RS232C/RS485 interfacing, Standard commands for programmable instruments, VISA, Instrument interfacing and LabVIEW.

Unit-5 **Analysis Techniques and Communication**: DSP software, Measurement, filters and wavelets, windows, curve fitting probability & statistics, basic networking methods and their applications in instrumentation, use of data sockets for distributed control.

Text Books:

1. Barney George C. ***Intelligent instruments***. Hemel Hempsteao: Prentice Hall. New Jersey (1995).
2. Bhuyan Manabendra. ***Intelligent Instrumentation Principles andApplications***. CRC Press, United States (2011).
3. Lisa. K. Wells and Jeffery Travis.***Lab VIEW For every one.***Prentice Hall (1997).

Reference Books:

1. Gupta Sanjay. ***P.C Interfacing for data Acquisition & Process Control, 2nd Edition***. Instrument Society of America, United States (1994).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Have a thorough understanding of the fundamental concepts of DAS, intelligent instruments and its characteristics.
2. Understand the basic building blocks of smart sensors their applications and interfacing devices.
3. Ability to design intelligent instrumentation system.
4. Ability to analyse and measure the parameters using the latest software & hardware devices.

EI 491	Advanced Process Control	L T P C
	B. Tech (Electronics & Instrumentation Engg.) 8th Semester(Open Elective-III)	**3 0 0 3**

Unit-1 **Review of process control:** Need and objectives of process control, Process control hierarchy. Introduction to multivariable control and distributed control. Regulatory control and set-point tracking control. Programmable logic controllers. Need of process model. Distributed control system. Human-machine interface.

Unit-2 **Mathematical modelling using first principles:** Modelling of interacting systems. Empirical modelling (linear) from process data (step, pulse, and random signals). Linear least square method for parameter estimation.

Unit-3 **Design of feedback controller:** ON-OFF control. Modified ON-OFF control. Multi-position control. Proportional control. Effect of integral and derivative action. Proportional-integral control. Proportional-integral- derivative control. Advantages and limitations of various control strategies and measures to overcome the limitations. Practical implementation of controllers. Performance criteria for controllers. Tuning of PID controllers (minimum one openloop and one closedloop method).

Unit-4 **Advanced process control:** Feedforward control. Cascade control. Ratio control. Time-delay compensation. Override control. Inferential control.

Unit-5 **Control of multivariable process:** Relative gain array method for inter-action analysis. Brief introduction to decentralised control. Decoupling and strategies for reducing control loop interactions. Overview of model predictive control.

Unit-6 **Process control instrumentation and plant design:** Overview of different final control elements. Transducers and transmitters. Various industrial communication protocols. Plant wide control system design. Piping and instrumentation diagram.

Unit-7 **Case studies (self study/Group presentations):** Control strategy for boiler drum level and combustion chamber. Control strategy for binary distillation column. Control of CSTR. Safety in process plants with different case studies.

Text Books:

1. Dale Seborg, Edgar Thomas and Mellichamp Duncan. ***Process Dynamics and Control.*** Wiley, United States (2003).
2. Babatunde A. Ogunnaike and W. Harmon Ray**.** ***Process Dynamics, Modeling, and Control.*** Oxford university press, London(1994).

Reference Books:

1. Bequette B. Wayne. ***Process Control: Modeling, Design and Simulation***. Prentice Hall, New Jersey (2003).
2. Luyben William. ***Process Modeling,Simulation and Control***. McGraw hill pub- lishers, New York (2014).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain the basic principles and importance of process control in industrial process plants.
2. Ability to empirically determine process dynamics from process input output data**.**
3. Design control systems for a given process based on its dynamic behavior.
4. Fine tune control systems using different tuning techniques.
5. Implement control loops using the correct instrumentation and final elements.

EI 492	**Bio-signal Processing**	**L**	**T**	**P**	**C**
	B. Tech (Electronics & Instrumentation Engg.) **8th Semester(Open Elective-III)**	**3**	**0**	**0**	**3**

Unit-1 **Sources of Biomedical signals:** Introduction, types of signals – Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT, FFT algorithm – Digital filters – Introduction to FIR and IIR filter.

Unit-2 **Classical Spectral Estimation Techniques:** Periodogram, Blackman – Tukey spectral Estimation applications – analysis of the Doppler signal using the Periodogram, analysis of Auditory Evoked potentials (AEP) using periodogram, analysis of Heart rate variability using the periodogram cepstrum anlaysis – Cepstra, power cepstrum, applications of cepstrum analysis – analysis of the ECG signal using cepstrum technique, analysis of Diastolic Heart sound using cepstrum technique.

Unit-3 **Adaptive Noise Cancellation:** Introduction, principle of adaptive noise cancelling, adaptive Noise cancellation with the LMS and RLS adaptation algorithm - applications – adaptive noise cancelling method to enhance ECG monitoring, adaptive noise cancelling method to enhance Fetal ECG monitoring, adaptive noise cancelling method to enhance Electro gastric measurements.

Unit-4 **Parametric Modelling Methods:** Autoregressive (AR) methods Linear Prediction and Autoregressive methods, the autocorrelation (Yule - walker) methods, applications of AR methods AR modelling of seizure EEG, ECG signals and surface EMG. Autoregressive Moving Average (ARMA) method – MLE method, Akaike method, Durbin method, applications – ARMA modelling of somatosensory Evoked Potentials (SEPs), Diastolic Heart sounds and cutaneous Electro gastric signals.

Unit-5 **Non Linear Biosignal Processing And Wavelet Transform:** Clustering methods – hard and fuzzy clustering, applications of Fuzzy clustering to Biomedical signal processing, Neural Networks – Introduction – NN in processing and analysis of Biomedical signals wavelet transform – Introduction, Filter bank implementation of discrete wavelet transform, signal Denoising using wavelet transform, wavelet based compression.

Text Books:

1. Akay Metin. ***Biomedical Signal Processing.*** Academic Press, San Diego. (1994).
2. Akay Metin. ***Nonlinear Biomedical Signal Processing, Fuzzy Logic, Neural Networks and New Algorithms (vol1)***, IEEE Press series on Biomedical Engineering, United States (2000).

Reference Books:

1. Eugene.N. Bruce. ***Biomedical Signal Processing and Signal Modeling***, Wiley publications, New Jersey (2000).

Course Outcomes (COs):

At the end of the course, students are expected to

1. To understand various methods of acquiring bio signals.
2. To understand various sources of bio signal distortions and its remedial techniques.
3. Implement basic principles and techniques in designing non-linear bio signal systems.
4. To analyze ECG and EEG signal with characteristic feature points.
5. Apply knowledge of bio signal processing to model a biomedical system

EI 493	**Advanced Memory Technology**	**L**	**T**	**P**	**C**
	B. Tech (Electronics & Instrumentation Engg.) 8th Semester(Open Elective-III)	**3**	**0**	**0**	**3**

Unit-1 **Introduction to memory devices:** Evolution and history; archival data storage; classification of memory technologies, advances in optical memories.

Unit-2 **Nonvolatile memories:** Magnetic memories, HDDs; Silicon based thin film transistor nonvolatile memories; Flash memories, classification and operation; challenges; advancements.

Unit-3 **Volatile memories:** Random access memories, classification and operation; SRAMs; DRAMs; history and challenges.

Unit-4 **Emerging memory technologies:** Resistive Random Access Memory (ReRAM), Phase Change Memory (PCM); Magnetoresistive Random Access

Memory (MRAM); Ferroelectric Random Access Memory (FeRAM); Comparison and future directions.

Text Books:

1. Tseng Tseung-Yuen and Sze Simon M*. **Nonvolatile memories Materials, Devices and Applications, Volume 1 and 2,*** American Scientific Publishers, United States (2012).
2. Brewer Joe E. and Gill Manzur. ***Nonvolatile memory technologies with emphasis on Flash***, IEEE Press series on microelectronic systems, Wiley-Interscience, United States (2008).
3. Raoux Simone and Wuttig Matthias. ***Phase change materials-Science and Applications***, Springer Science+Business Media, Berlin (2009).

Reference Books:

1. Lai Stefan k. ***Review article: Flash memories: Successes and challenges, IBM Journal of Res. And Dev. Vol.52, p529***. (2008).
2. Wong H-S. Philip. ***Review article: Phase change memory, Proceedings of the IEEE,*** United States (2010).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Acquire knowledge about history and evolution in data storage techniques
2. Represent any architecture design for memory devices.
3. Implement different design methodologies for volatile and non-volatile memories.
4. Apply knowledge of memory technology for practical implementations in engineering applications.

EI 494	**Introduction to Cyber-Physical Systems**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **8th Semester (Open Elective-III)**	**3 0 0 3**

Unit-1 **CPS Review & Background:** Course introduction & syllabus, prerequisites, major applications, course overview.

Unit-2 **Linear & Nonlinear Networked Systems Theory:** Recent relevant theories on linear and nonlinear systems.

Unit-3 **State Observation & Estimation of CPSs**: Dynamic state estimation of dynamic CPSs.

Unit-4 **CPSs & Convex Optimization:** Basic principles on convex optimization for generic systems.

Unit-5 **Optimal Control of CPSs:** Linear quadratic regulator, optimal state-feedback control, principle of optimality.

Unit-6 **Networked Control Systems:** Recent results on networked control systems, fault detection, cyber-attacks.

Unit-7 **Applications:** Smart-grids, transportation networks, robotics.

Text Books:

1. Chen Chi Tsong. ***Linear System Theory and Design***, Oxford University Press, London (1995).
2. Wang Fei Yue and Liu Derong. ***Networked Control Systems, Theory and Applications.*** Springer-Verlag, London (2008).
3. Lee Edward A. and Seshia Sanjit Arun K. ***Introduction to Embedded Systems, A Cyber-Physical Systems Approach,*** MIT press, United States (2011).

Reference Books:

1. Boyd S. and Vandenberghe L. ***Convex Optimization***. Cambridge University Press, Cambridge (2004).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the basics of CPS.
2. Analyze the modern linear and non-linear CPSs.
3. Perform state space analysis of dynamic CPSs.
4. Analyze basic principles of convex optimization, optimal control and network-controlled
5. Apply knowledge of CPS for practical implementations in engineering applications.

EI 495	**Optimization Methods in Engineering**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **8th Semester (Open Elective-III)**	**3 0 0 3**

Unit-1 **Introduction:** Statement of Optimization problem, classification. Classical Optimization Techniques: Single variable Optimization, Multivariable optimization (with no constraints, equality constraint & inequality constraints).

Unit-2 **Linear Programming:** Standard form of linear programming problem, definition and theorem, Solution of a system of Linear simultaneous equation, Simplex methods, simplex algorithm, Two phases of simplex method Duality in linear programming, sensitivity analysis, transportation problem.

Unit-3 **Non-linear Programming:** One dimensional minimization: Unimodal function, elimination methods, Fibonacci method, Golden section method, quadratic interpolation method. Unconstrained optimization: Direct search method – Hooke & Jeeves pattern search method. Descent method – Fletcher-Reeves method. Constrained Optimization: Direct method– Cutting plane method, Indirect method – Penalty function method both interior and exterior method.

Unit-4 Integer Programming Integer linear programming-graphical representation, cutting plane method. Nonlinear programming-Integer polynomial programming.

Unit-5 Non-traditional Optimization Algorithm Genetic Algorithm – Working principle, Difference and similarities between GAs and traditional methods, GAs for constrained optimization.

Text Books:

1. Rao S.S. ***Optimization Theory and Application***, John Wiley & Sons, New york (1978).
2. Kalyanmoy Deb. ***Optimization for Engineering Design***. Prentice Hall of India Pvt Ltd., New Delhi (2004).
3. Arora Jasbir S. ***Introduction to Optimum design***. Academic Press, United States (1989).

Reference Books:

1. Mittal K. V. and Mohan C. ***Optimization methods in Operations Research and Systems Analysis***. **New Age** International Private Limited, New Delhi (2016).
2. Ravindran A., Phillip Don T. and Solberg James J.. ***Research and System Analysis Operation Research, principles and practise***. John Wiley & Sons, New York (1987).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Define optimization problems
2. Understand and design mathematical modelling of optimization problems.
3. Apply suitable optimization techniques for particular type of problems.
4. Understand the benefits and drawbacks of different optimization tools.
5. Develop new or modify existing algorithm for solution of critical optimization problems

EI 496A	Information Theory, Cryptography & Security	L T P C
	B. Tech (Electronics & Instrumentation Engg.) 8th Semester (Open Elective-III)	**3 0 0 3**

Unit-1 **Introduction to information Theory:** Shannon's theorem, Information and entropy, properties of entropy of a binary memory less source, Measure of Information, Source Coding, Shannon Fano coding, Huffman coding, Lempel Ziv coding, channel coding, Channel capacity, noisy channel coding theorem for DMC.

Unit-2 **Linear block codes:** Generator matrices, parity check matrices, encoder syndrome and error detection minimum distance, error correction and error detection capabilities, cyclic codes, coding and decoding.

Unit-3 **Coding convolutional codes:** Encoder, generator matrix, transform domain representation state diagram, distance properties, maximum likelihood decoding, Viterbi decoding, sequential decoding and interleaved convolutional codes. Special topics in information theory and coding.

Unit-4	**Overview of cryptography:** simple classical cryptosystems, cryptanalysis, Perfect secrecy-information theoretic security.

Text Books:

1. Bose Ranjan. ***Information Theory Coding and Cryptography***. Tata McGraw Hill, New Delhi (2008).
2. MacWilliams Florence J. and Sloane Neil James Alexander. ***The Theory of Error Correcting Codes.*** Elsevier, United States (1976).
3. Moreira Jorge Castiñeira and Farrell Patrick Guy. ***Essentials of Error-Control Coding.*** John Wiley & Sons, New York. (2006).

Reference Books:

1. Cover T. M. and Thomas J. A., ***Elements of Information Theory***, John Wiley & Sons, New York (1991).
2. Welsh Dominic, ***Codes and Cryptography***, Oxford Science Publications, London (1988).

Course Outcomes (COs):

At the end of the course, students are expected to
1. Understand the fundamentals of information theory & several source coding techniques.
2. Apply linear block codes for error detection and correction with encoding & decoding techniques.
3. Acquire knowledge of convolution codes with transform domain representation, state diagram & several decoding techniques.
4. Learn the fundamentals of Cryptography and network security.

EI 496B	**Modelling and Control of Energy Storage Systems**	**L T P C**
	B. Tech (Electronics & Instrumentation Engg.) **8^{th} Semester (Open Elective-III)**	**3 0 0 3**

Unit-1	**Introduction:** Need of energy storage; various types of energy storage systems; applications.
Unit-2	**Modelling:** Working, characteristics, and modelling (electrical/ electro thermal/ electrochemical/ electromechanical) of battery, super capacitor, fuel cell, etc.
Unit-3	**Estimation:** Introduction; Applications; state and parameter estimation of energy storage systems.
Unit-4	**Control:** Charging and discharging control under various constraints; rule based; optimal.
Unit-5	**Case Study I**: Simulation study on modelling estimation and control of one energy storage system.

Case Study II: Applications- Transportation (electric/hybrid electric vehicle); Wireless sensor network; smart grid.

Text Books:

1. Wang Chao-Yang and Rahn Cristopher D. ***Battery Systems Engineering***. John Wiley &Sons, New York (2012).
2. Gou Bei and Diong Bill. ***Fuel Cell: Modelling, Control, and Applications***. CRC Press, United States (2009).
3. Tarascon Jean Marie and Simon Patrice. ***Electrochemical Energy Storage - Battery and Supercapacitor Set***. John Wiley & Sons, New York (2015).

Reference Books:

1. Lewis Frank, Xie Lihua, and Popa Dan. ***Optimal and Robust Estimation: with an Introduction to Stochastic Theory.*** CRC Press, United States (2007).
2. Naidu Desineni S. ***Optimal control***. CRC Press, United States (2002).

Course Outcomes (COs):

At the end of the course, students are expected to

1. Explain various types of energy storage systems with applications
2. Perform modeling of various types of battery with super capacitor, fuel cell etc.
3. Implement state and parameter estimation of energy storage systems with application.
4. Analyze the charging and discharging control under various constraints.