SYLLABUS

FOR

B. TECH.

IN

ELECTRONICS & INSTRUMENTATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY
SILCHAR

(FOR 2018 ENTRY BATCH)

Course Structure for B Tech (4 Year, 8 Semester Course) in Electronics and Instrumentation Engineering, NIT Silchar

(*to be applicable from entry batch 2018 onwards*)

Course No	Course Name	L	T	P	C		Course No	Course Name	L	T	P	C
Semester-1							**Semester-II**					
Semester-III							**Semester-IV**					
EI-201	Electrical & Electronic Measurements	3	1	0	4		EI-204	Sensors and Transducers	3	1	0	4
MA-xxx	Mathematics III	3	1	0	4		EI-205	Signals and Systems	3	1	0	4
EI-202	Analog Electronics	3	1	0	4		EI-206	Control System-I	3	1	0	4
EI-203	Circuits & Networks	3	1	0	4		EI-207	Digital Electronics	3	1	0	4
CS-xxx	Data Structures	3	1	0	4		EI-208	Power Electronics & Drives	3	0	0	3
EI-211	Measurement Lab	0	0	3	2		EI-214	Sensor and Transducers lab	0	0	3	2
EI-212	Analog Electronics Lab	0	0	3	2		EI-215	Control System Lab	0	0	3	2
EI-213	Circuits & Networks Lab	0	0	3	2		EI-216	Digital Electronics Lab	0	0	3	2
CS-xxx	Programming & Data Structures Lab	0	0	3	2		EI-217	Power Electronics Lab	0	0	3	2
	Total	**15**	**5**	**12**	**28**			Total	**15**	**4**	**12**	**27**
Semester-V							**Semester-VI**					
EI-301	Industrial Instrumentation-I	3	1	0	4		EI-306	Industrial Instrumentation-II	3	1	0	4
EI-302	Microprocessors & Micro Controllers	3	1	0	4		EI-307	Process Control Engineering	3	1	0	4
EI-303	Biomedical Instrumentation	3	0	0	3		EI-308	Digital Signal Processing	3	1	0	4
EI-304	Control System-II	3	1	0	4		EI-xxx	Elective I	3	1	0	4
EI-305	Communication & Telemetry	3	1	0	4		EI-xxx	Open Elective-I	3	1	0	4
EI-311	Microprocessors & Micro Controllers Lab	0	0	3	2		EI-315	Instrumentation Lab	0	0	3	2
EI-312	Biomedical Instrumentation lab	0	0	3	2		EI-316	Industrial Process Control and Automation Lab	0	0	3	2
EI-313	Communication & Telemetry Lab	0	0	3	2		EI-317	Digital Signal Processing Lab	0	0	3	2
EI-314	Virtual Instrumentation Lab	1	0	3	3		EI-318	Simulation, Design & Fabrication Lab	0	0	3	2
	Total	**16**	**4**	**12**	**28**			Total	**15**	**5**	**12**	**28**
Semester-VII							**Semester-VIII**					
EI-401	Analytical & Optical Instrumentation	3	1	0	4		HS-xxx	Business Management	3	0	0	2
EI-xxx	Elective II	3	1	0	4		EI-xxx	Elective III	3	1	0	4
EI-xxx	Open Elective II	3	0	0	3		EI-xxx	Open Elective III	3	0	0	3
HS-xxx	Managerial Economics	3	0	0	2		EI-491	Project II	0	0	9	6
EI-490	Project I	0	0	9	6							
	Total	**12**	**2**	**9**	**19**	`		Total	**9**	**1**	**9**	**15**

ELECTIVES (for B Tech in Electronics and Instrumentation Engineering, NIT Silchar**)**

Course No	Course Name	L	T	P	C		Course No	Course Name	L	T	P	C
Elective-I							**Open Elective-I**					
EI-321	IC and VLSI Design	3	1	0	4		EI-331	Environmental Pollution Control	3	1	0	4
EI-322	Power Plant Instrumentation	3	1	0	4		EI-332	Opto-electronics and fiber optics	3	1	0	4
EI-323	Computer networks	3	1	0	4		EI-333	Digital Image Processing	3	1	0	4
EI-324	PC Based Instrumentation	3	1	0	4		EI-334	Wind and solar based system	3	1	0	4
EI-325	Electro-Magnetic Field Theory	3	1	0	4		EI-335	Soft Computing Techniques and Applications	3	1	0	4
EI-326	Smart Sensors	3	1	0	4		EI-336	Wireless Sensor Networks	3	1	0	4
EI-327	Optimization techniques	3	1	0	4		EI-337	Logic and Distributed Control	3	1	0	4
Elective- II							**Open Elective-II**					
EI-421	Advanced Instrumentation	3	1	0	4		EI-431	Robotics and Automation	3	0	0	3
EI-422	Biomedical signal processing	3	1	0	4		EI-432	Instrumentation In Petrochemical Industry	3	0	0	3
EI-423	Real Time Embedded Systems	3	1	0	4		EI-433	Neural Networks and Fuzzy logic	3	0	0	3
EI-424	IoT based Instrumentation	3	1	0	4		EI-434	Renewable Energy Systems	3	0	0	3
EI-425	MEMS & Nanotechnology	3	1	0	4		EI-435	Machine Learning	3	0	0	3
EI-426	Non Linear control systems	3	1	0	4		EI-436	Probability and Random Processes	3	0	0	3
EI-427	Linear Integrated Circuits	3	1	0	4		EI-437	Human Computer Interfaces	3	0	0	3
							EI-438	Mobile Adhoc and sensor networks	3	0	0	3
							EI-439	Aquaponics monitoring and control	3	0	0	3
Elective-III							**Open Elective-III**					
EI-441	Advanced Sensors and Signal Processing	3	1	0	4		EI-451	Intelligent Instrumentation	3	0	0	3
EI-442	Piping and Instrumentation	3	1	0	4		EI-452	Advanced Process Control	3	0	0	3
EI-443	Industrial Automation	3	1	0	4		EI-453	Bio-signal Processing	3	0	0	3
EI-444	Wireless Communication	3	1	0	4		EI-454	Advanced Memory Technology	3	0	0	3
EI-445	Adaptive Control	3	1	0	4		EI-455	Introduction to Cyber Physical systems	3	0	0	3
EI-446	Analog Integrated Circuit Design	3	1	0	4		EI-456	Optimization Methods in Engineering	3	0	0	3
EI-447	Mechatronics	3	1	0	4		EI-457	Information Theory, Cryptography & Security	3	0	0	3
							EI-458	Modelling and Control of Energy Storage	3	0	0	3
							EI-459	Aerospace and Navigation Instrumentation	3	0	0	3

SYLLABUS

3RD SEMESTER

EI-201 **Electrical & Electronic Measurements**

L	T	P	C
3	1	0	4

Pre-requisite – Basic Electrical Engineering

UNIT I: Measurement and error:
Introduction, Definition, significance of measurement, Measurement characteristics, Calibration of instruments, Static & dynamic characteristics. Types of errors, Statistical analysis, Probability of errors, Limiting error with examples.

UNIT II: Electrical Measuring instruments:
Classification of instruments, Overview of PMMC, Moving iron, Dynamo Meter type instruments, Galvanometer, different types of galvanometer and it's application. Overview of Ammeter, Voltmeter & Multimeter, True rms voltmeter, Potentiometers. Extension of range of instruments- shunts & multipliers- Current transformers- Potential Transformers.

UNIT III: A. C And D. C Bridges:
General equation for bridge balance, 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, Wagner earthing device.

UNIT IV: 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 of all.

UNIT V: Electronic measuring Instruments:
Measurement of quality factor (Q), Digital voltmeter (DVM)-Ramp type, Integrating type, ADC, Digital frequency meter, CRO, Construction, Time based circuit, Measurement with CRO, CRO probes. DSO-construction, working principle and applications.

UNIT VI: Signal generations and waveform analyzing instruments:
Function generator-Square, triangular Sinusoidal waveform generator, Spectrum analyzer.

TEXT BOOKS/REFERENCES:

1. Electrical and Electronic Measurements & Instrumentation By A.K. Sawhney - Dhanpat Rai
2. Electronic Measurement & Instrumentation By H. Cooper – PHI.
3. Electronic Instrumentation by H. S. Kalsi – McGraw HilI.

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EI-202 **Analog Electronics**

L	T	P	C
3	1	0	4

Pre-requisite – Basic Electronics

UNIT I:
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, adder, subtractor, integrator, differentiator, Comparator, Clipper, clamper, Schmitt Trigger, Instrumentation Amplifier, Logarithmic amplifiers rectifiers.

UNIT II:
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 III:

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 IV:

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 V:

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.

Text Books:

1. Electronic Devices and Circuits theory, 9th/10th Edition, R.L. Boylestadand L.Nashelsky, Pearson Education, New Delhi.
2. Microelectronics Circuits, 5th Edition, International Student Edition Sedra and Smith, Oxford University Press, New Delhi.
3. Electronic Devices and Circuits, 3rd Edition, Jimmie J. Cathey adapted by Ajay Kumar Singh, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

1. Electronics Circuits Analysis and Design, 3rd Edition, Donald A. Neamen, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Milliman's Electronics Devices and Circuits, 2nd Edition, J. Milliman, C. Halkias, S. Jit., Tata McGraw Hill Education Pvt. Ltd., New Delhi
3. Integrated Electronics: Analog and Digital Circuits and Systems, J. Milliman, C. Halkias, Tata McGraw Hill Publishing Company Ltd., New Delhi.

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EI-203 Circuits & Networks

L	T	P	C
3	1	0	4

Pre-requisite – Basic Electrical Engineering

UNIT I : BASIC CIRCUIT CONCEPTS

Lumped circuits, circuits elements, V-I relationships of R, L and C, independent sources, dependent sources, simple resistive circuits, Kirchhoff's Laws, analysis of series and parallel circuits, network reduction, voltage division, current division, source transformation, star-delta transformation.

UNIT II : SINUSOIDAL STEADY STATE ANALYSIS

Concepts of phasor and complex impedance and admittance, analysis of simple series and parallel circuits, 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 III : 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 IV : 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, free response, step and sinusoidal responses, natural frequency, damped frequency, damping factor and logarithmic decrement, response of circuits for non-sinusoidal periodic inputs.

UNIT V : TWO PORT NETWORK AND FILTERS

Driving point and transfer impedances, admittances, voltage and current ratios of two port networks, admittance, impedance, hybrid – transmission and image parameters for two port networks, impedance matching, equivalent Π and T networks, passive filters as a two port network, characteristics of ideal filter, low pass and high pass filters.

TEXT BOOKS

1. W.H. Hyatt Jr. and J.E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill International Editions.
2. M. Nahvi and J.A. Edminister, "Electric Circuits", Schaum's outline series McGraw-Hill, Fourth Edition.

REFERENCES

1. A. Sudhakar and S.P. Shyam Mohan, “Circuits and Network Analysis and Synthesis”,Tata McGraw Hill, 2007.
2. M. Arumugam and N. Premkumar, “Electric circuit Theory”, Khanna Publishers, 1991.
3. A. Chakrabarti, “Circuit Theory – Analysis and Synthesis”, Dhanpat Rai & Co., 2001.
4. Nilsson and Riedel, “Electric Circuits”, Eighth Edition, Pearson Education, 2008.

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CS-xxx **Data Structures**

L	T	P	C
3	1	0	4

Pre-requisite – None

LINEAR STRUCTURES

Abstract Data Types (ADT) – List ADT – array-based implementation – linked list implementation – cursor-based linked lists – doubly-linked lists – applications of lists – Stack ADT – Queue ADT – circular queue implementation – Applications of stacks and queues

TREE STRUCTURES

Need for non-linear structures – Tree ADT – tree traversals – left child right sibling data structures for general trees – Binary Tree ADT – expression trees – applications of trees – binary search tree ADT

BALANCED SEARCH TREES AND INDEXING

AVL trees – Binary Heaps – B-Tree – Hashing – Separate chaining – open addressing – Linear probing

GRAPHS

Definitions – Topological sort – breadth-first traversal - shortest-path algorithms – minimum spanning tree – Prim's and Kruskal's algorithms – Depth-first traversal – biconnectivity – Euler circuits – applications of graphs

ALGORITHM DESIGN AND ANALYSIS

Greedy algorithms – Divide and conquer – Dynamic programming – backtracking – branch and bound – Randomized algorithms – algorithm analysis – asymptotic notations – recurrences – NP-complete problems

TEXT BOOKS:

1. M. A. Weiss, “Data Structures and Algorithm Analysis in C”, Pearson Education Asia, 2002. 2. ISRD Group, “Data Structures using C”, Tata McGraw-Hill Publishing Company Ltd., 2006.

REFERENCES

1. AhoA.V, Hopcroft.J.E, and Ullman.J.D, “Data Structures and Algorithms”, Pearson Education, 1983.
2. Gilberg.R.F, Forouzan.B.A, “Data Structures: A Pseudocode approach with C”, Second Edition, Thomson India Edition, 2005.
3. Sara Baase and A. Van Gelder, “Computer Algorithms”, Third Edition, Pearson Education, 2000.
4. Cormen.T.H, Leiserson.C.E, Rivest.R.L, and Stein.C, "Introduction to algorithms", Second Edition, Prentice Hall of India Ltd, 2001.

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EI-211 **Measurement Lab**

L	T	P	C
0	0	3	2

Pre-requisite – Electrical & Electronic Measurements

List of Experiments (Any Fourteen experiments as instructed by course coordinators)

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

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EI-212 **Analog Electronics Lab**

L	T	P	C
0	0	3	2

Pre-requisite – Analog Electronics

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.

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EI-213 **Circuits & Networks Lab**

L	T	P	C
0	0	3	2

Pre-requisite – Basic Electrical Engineering, CKTs & Networks

1. Transient response in R-L and R-C Network: Simulation/hardware
2. Transient response in R-L-C Series & Parallel circuits Network: Simulation/hardware
3. Determination of Impedance (Z) and Admittance(Y) parameters of two port network
4. Frequency response of LP and HP filters
5. Frequency response of BP and BR filters

6. Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, Ramp signals using MATLAB in both discrete and analog form
7. Evaluation of convolution integral, Discrete Fourier transform for periodic & non-periodic signals and simulation of difference equations using MATLAB
8. 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
9. Determination of Laplace transform and inverse Laplace transformation using MATLAB
10. a) Study of RC low pass filter as an integrator
    b) Study of frequency response of low pass filter
11. a) Study of RC high pass filter as an differentiator
    b) Study of frequency response of high pass filter
12. Design of different clipper circuits
14. Study of different clamper circuits: positive, negative & bias
15. Design & study of Frequency response of two stage RC coupled amplifiers
16. Study of power amplifiers

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		L	T	P	C
CS-xxx	**Programming & Data Structures Lab**	**0**	**0**	**3**	**2**

Pre-requisite-Data Structure

1. Implement singly and doubly linked lists.
2. Represent a polynomial as a linked list and write functions for polynomial addition
3. Implement stack and use it to convert infix to postfix expression
4. Implement array-based circular queue and use it to simulate a producer- consumer problem.
5. Implement an expression tree. Produce its pre-order, in-order, and post-order traversals.
6. Implement binary search tree.
7. Implement insertion in AVL trees.
8. Implement priority queue using heaps
9. Implement hashing techniques
10. Perform topological sort on a directed graph to decide if it is acyclic.
11. Implement Dijkstra's algorithm using priority queues
12. Implement Prim's and Kruskal's algorithms
13. Implement a backtracking algorithm for Knapsack problem
14. Implement a branch and bound algorithm for traveling salesperson problem
15. Implement any randomized algorithm.

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4th SEMESTER

		L	T	P	C
EI-204	**Sensors and Transducers**	**3**	**1**	**0**	**4**

Pre-requisite – Basic Electrical Engineering

UNIT I

Introduction, General concepts and terminology of measurement systems, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data. Standards and Calibration. Transducers and sensors, classification, emerging fields of sensor technologies.

UNIT II

Variable resistance 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 III

Inductive transducers- Transformer type, synchros, eddy current transducers, proximity detectors. Tacho generators and stroboscope. Capacitive transducers, capacitive microphone.

UNIT IV

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 V

Thermocouples: Thermoelectric effects, laws of thermocouple, cold junction compensation techniques, thermocouple types, construction, measuring circuits, thermocouple burn out detection and high temperature measurement methods. Temperature measurement: Resistance temperature detector (RTD), principle and types, construction requirements for industry, measuring circuits. Thermistors, principle and sensor types, measuring circuits, linearization methods and applications. Digital displacement sensors, Semiconductor sensor.

Text Books:

1. Murthy D. V. S, "Transducers and Instrumentation", Prentice Hall, New Delhi.
2. Patranabis, "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd.
3. Doebelin E.O, "Measurement Systems - Application and Design", 4th Edition, McGraw-Hill, New York, 2003.

Reference Books:

1. Neubert H.K.P, "Instrument Transducers - An Introduction to their Performance and Design", 2nd Edition, Oxford University Press, Cambridge.
2. Waldemar Nawrocki, "Measurement Systems and Sensors", Artech House.
3. S.M. Sze, "Semiconductor sensors", John Wiley & Sons Inc., Singapore.
4. B. C. Nakara & Chaudhry, "Instrumentation Measurement and Analysis", TATA McGraw-Hill, New Delhi.

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		L	T	P	C
EI-205	**Signals and Systems**	**3**	**1**	**0**	**4**

Pre-requisite – None

UNIT I 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 II ANALYSIS OF CONTINUOUS TIME SIGNALS

Fourier series for periodic signals, Fourier Transform & properties, Laplace Transforms and properties

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS

Impulse response, convolution integrals, Differential Equations, Fourier and Laplace transforms in Analysis of CT systems, Systems connected in series / parallel.

UNIT IV 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 V 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.

Books:

1. A. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
2. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
3. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.

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EI-206	Control System-I	L	T	P	C
		3	1	0	4

Pre-requisite – Basic Electrical Engineering, Signals & Systems

Mathematical modelling of linear time invariant systems (LTI): Differen- tial equation of physical Systems – mechanical, electrical Systems, thermal and hydraulic systems. Concept of analogous systems. Laplace transform, Transfer function, Solution of set of differential equations using Laplace transformation. Concept of poles and zeros. System order and type num- ber. Brief introduction to non-LTI systems, distributed systems, discrete systems.
Block diagram and signal flow graph analysis.
System analysis (time-domain): Time response of first-order and second- order systems. Steady state errors and error constants.
Characteristics of feedback control: Effect of feedback in stability, steady- state accuracy, transient accuracy, disturbance rejection, insensitivity, and robustness.
Stability analysis: Concepts of stability. Necessary conditions for Stability. Routh stability criterion. Relative stability analysis. Introduction to root- locus techniques.
System analysis (frequency-domain): Bode plots. Experimental determi- nation of transfer function. Introduction to Polar Plots. Nyquist plots. Nyquist Stability criterion (time delay systems excluded).
Design (and development) of simple control system.

Text Books:

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

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EI-207	Digital Electronics	L	T	P	C
		3	1	0	4

Pre-requisite – Basic Electronics

UNIT I 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 II 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 III 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 IV 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 V 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.
UNIT VI: 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.

Books:
1. Digital Logic & Computer Design M. Morris Mano PHI
2. Fundaments of Digital Circuits – A. Anand Kumar, PHI

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EI-208	Power Electronics & Drives	L	T	P	C
		3	0	0	3

Pre-requisite – Basic Electrical Engineering, Analog Electronics

Introduction: Power electronics – needs; special features; advantages
Power Semiconductor Devices: Power diode, Power transistor, power MOSFET, SCR, TRIAC, GTO, IGBT, MCT.
DC to DC Converters: Principle of chopper operation, Control strategies, Types of chopper circuits, Buck, Boost, Buck-boost converter; Steady state time-domain analysis of chopper.
AC to AC converters: Introduction; single and three phase ac voltage controller; Single phase half-wave cyclo-converters.
Drives: Control of DC motor using converters and choppers, Closed loop control scheme, Speed-torque characteristics and control of induction motor.

Text Books
1. Power Electronics: Circuits, Devices and Applications, M H Rashid, Pearson.
2. Power Electronics – Converters, Applications and Design, Ned Mohan, T. M. Undeland and William P. Robbins; John Wiley & Sons, Inc.
3. Power Electronics, P. S. Bimbhra, Khanna Publishers.

Reference Books:
1. Power Electronics: Devices, Drivers and Applications, B. W. Williams, Macmillan, London.
2. Power Electronics, C. W Lander, Mc Graw Hill
3. Power Electronics, L. Umanand, Wiley India Pvt. Ltd.
4. Modern Power Electronics and A.C. Drives," B. K. Bose, PHI.

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EI-214	Sensors and Transducers lab	L	T	P	C
		0	0	3	2

Pre-requisite – Sensors and Transducers

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

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EI-215	Control System Lab	L	T	P	C
		0	0	3	2

Pre-requisite – Control Systems

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.

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EI-216	Digital Electronics Lab	L	T	P	C
		0	0	3	2

Pre-requisite – Basic Electronics

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.

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EI-217 **Power Electronics Lab**

L	T	P	C
0	0	3	2

Pre-requisite – Power Electronics

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.

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5th SEMESTER

EI-301 **Industrial Instrumentation-I**

L	T	P	C
3	1	0	4

Pre-requisite – Electrical & Electronic Measurements, Sensors & Transducers

Mechanical parameters
Introduction: why are the measurements of these parameters important in industry? Different methods for measurement of motion parameters: Displacement, velocity, acceleration, vibration, torque, force etc. Measurement of straightness, flatness, roundness and roughness.
Typical case study/design example: Instrumentation system for motion measurement in industry.
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 (RTD, T/C, Thermistor etc.).
Typical case study: Instrumentation system for Industrial temperature measurement and control.

Viscosity

Introduction; Various types and units of viscosity; Viscous fluid flow through capillary-derivation; 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.

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.

Humidity and Moisture

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.
Typical case study: Humidity and moisture measurement system in industrial environment.

Text Books:

1. Measurement Systems, Ernest O Doebelin & Dhanesh N Manik, McGraw Hill Education; 6 edition (July 2017)
2. Principles of Industrial Instrumentation, D Patranabis, McGraw Hill Education; 3 edition (July 2017)
3. A Course in Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai & Co. (P) Limited (2015)
4. Instrumentation, Measurement and Analysis, B. C. Nakra and K. K. Chaudhary, McGraw Hill Education India Private Limited; Fourth edition (1 August 2016)

Reference Book:

1. Instrument Engineers Handbook, B. G. Liptak, CRC Press; 4 edition (24 July 2012)

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		L	T	P	C
EI-302	**Microprocessors & Microcontrollers**	**3**	**1**	**0**	**4**

Pre-requisite – None

Module I: 8085 Microprocessor

ARCHITECTURE: General 8-bit microprocessor and its architecture, 8085 functional block diagram, architecture functions of different sections.

INSTRUCTION SETS: Instruction format, addressing 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.

Module II: 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.

Module III: 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.

Module IV: 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.

Module V: 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. Ramesh S Gaonkar, "Microprocessor Architecture, Programming and application with 8085", 4th Edition, Prentice Hall of India, New Delhi.
2. Ray & Bhurchandi – Advanced Microprocessors & Peripherals, Tata McGraw-Hill
3. Muhammed Ali Mazidi and Janice Gillispie Mazidi – The 8051 Microcontroller and Embedded Systems, Pearson Education Inc.

REFERENCE BOOKS:

1. Barry B. Brey – The Intel Microprocessors, PHI/Pearson Ed. Asia
2. Ajay V Deshmukh – Microcontrollers Theory and Applications, Tata McGraw-Hill
3. Walter A. Tribel – The 8088 and 8086 Microprocessors, Pearson Education
4. Douglas V. Hall – Microprocessors & Interfacing, Tata McGraw-Hill

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		L	T	P	C
EI-303	**Biomedical Instrumentation**	**3**	**0**	**0**	**3**

Pre-requisite – None

UNIT I :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 II :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 III :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 IV :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 V : 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. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Prentice Hall, New Delhi.
2. R. S. Kandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi.

Reference Books:

1. Nandini K.Jog, "Electronics in Medicine and Biomedical Instrumentation",4th Edition ,PHI.
2. Richard Aston, "Principles of Bio-medical Instrumentation and Measurement", Merril Publishing Company, New York.
3. Geddes L. A. and Baker L. E., "Principles of Applied Biomedical Instrumentation", 3rd Edition, John Wiley, New York.

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EI-304	Control System-II	L	T	P	C
		3	1	0	4

Pre-requisite – Control System-I

UNIT I: 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 II: 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 III: Similarity transformations, Stability in state space: Asymptotic stability, BIBO stability, relation between them and effect of pole zero cancellation,

UNIT IV: 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 V: Non-linear system analysis: Non-linear system behavior, 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. K Ogata, Modern Control Engineering, Prentice Hall Inc., New Jersey.
2. Norman S. Nise, Control Systems Engineering, Wiley.

REFERENCE BOOKS:

1. Jean-Jacques E. Slotine, Weiping Li, Applied nonlinear control, Prentice Hall Inc., New Jersey.
2. Vidyasagar .M, Nonlinear system analysis, Second Edition, Prentice Hall Inc., New Jersey.

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EI-305	Communication and Telemetry	L	T	P	C
		3	1	0	4

Pre-requisite – Signals and Systems

UNIT I: Introduction

Review of signals and systems, Review of Fourier series and Fourier Transform, Modulation-need for modulation, Frequency translation.

UNIT II: 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 III: 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 IV: 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 V: Source Coding and Line Coding

Line Coding, Information, entropy, Source coding-Huffmann and Shannon Fano.

UNIT VI: 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, Hamming. Review of modulation and multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc. Remote control and Industrial Telemetering systems.

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Text Books:

1. Communication Systems Engineering John G. Proakis, M. Salehi, PHI
2. Principles of Communication System, Taub and Schilling, McGraw Hill I.E.
3. Communication Systems, Simon Haykin, Wiley

Reference Books:

1. Telemetry principles, D. Patranabis TMH
2. Handbook of Telemetry and Remote control E. L. Gruenberg Mc Graw Hill

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		L	T	P	C
EI-311	**Microprocessors & Microcontrollers Lab**	**0**	**0**	**3**	**2**

Pre-requisite – Microprocessor & Microcontrollers

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.

		L	T	P	C
EI-312	**Biomedical Instrumentation Lab**	**0**	**0**	**3**	**2**

Pre-requisite – None

1. Computation of Convolution and Correlation Sequences.
2. Frequency analysis of biomedical signals using DFT and FFT computation.
3. FIR filter design using windowing techniques for biomedical signal analysis.
4. IIR filters design-digital Butterworth filter and Chebyshev filter for biomedical signal analysis.
5. Use of wavelet transform for noise removal of biomedical signals (e.g. ECG, EEG).
6. Feature extraction technique used for ECG signals- Detection of R-peak, PQR complex, R-R time etc.
7. Analysis of EMG signals.
8. Spectrum analysis
9. Frequency division and feature extraction technique for EEG signals.
10. Data reduction algorithms
11. BCI based experiments.

Hardware

1. EEG, ECG and EMG data acquisition using 32-channel Mobita Instrument
2. Detection of QRS component from ECG signals using analog circuits.
3. Design of Notch filter for elimination of 50Hz from ECG signal.

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		L	T	P	C
EI-313	**Communication and Telemetry Lab**	**0**	**0**	**3**	**2**

Pre-requisite – Communication and Telemetry

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.

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		L	T	P	C
EI-314	**Virtual Instrumentation Lab**	**1**	**0**	**3**	**3**

Pre-requisite – None

Teachers are required to explain the required theory and give demonstration along with hands on practice in the laboratory classes. The course requires engaging, hands-on curriculum that inspires students and puts theory into practice.

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.

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6th SEMESTER

		L	T	P	C
EI-306	**Industrial Instrumentation –II**	**3**	**1**	**0**	**4**

Pre-requisite – Industrial Instrumentation –I

UNIT I : 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 II : 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 III : 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
- 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 – IV :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 V: 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. R.K.Jain, "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi.
2. C. D. Johnson, "Process Control Instrumentation Technology", PHI
3. S.K. Singh, "Industrial Instrumentation and Control", Tata McGraw Hill Publishing Ltd., New Delhi

REFERENCE BOOKS:

1. D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw Hill Publishing Ltd., New Delhi,
2. Andrew W.G, "Applied Instrumentation in Process Industries – A survey", Vol. 1 & Vol.2, Gulf Publishing Company, Houston.
3. Ernest O. Doebelin, "Measurement systems Application and Design", International Student Edition, McGraw Hill.

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EI-307 Process Control Engineering

L	T	P	C
3	1	0	4

Pre-requisite –Introductory course in Control System.
MATLAB or similar computational software (For solving assignments).

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.
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.
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 open loop and one closed loop method).
Advanced process control: Feedforward control. Cascade control. Ratio control. Time-delay compensation. Override control. Inferential control.
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.
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.
Case studies (self study/Group presentations): Control strategy for boiler drum level and combustion chamber. Control strategy for binary distil- lation column. Control of CSTR. Safety in process plants with different case studies.

Text Books:

1. Seborg Dale, Thomas Edgar, and Duncan Mellichamp. Process Dynamics and Control. Wiley, 2nd Edition, 2003, ISBN: 978-0471000778.
2. Babatunde A. Ogunnaike, and W. Harmon Ray. Process Dynamics, Mod- eling, and Control. Oxford university press, 1994, ISBN: 978-0195091199.
3. B. Wayne Bequette. Process Control: Modeling, Design and Simulation. Prentice Hall, 2003, ISBN: 978-0133536409.
4. W. Luyben. Process Modeling,Simulation and Control. McGraw hill pub- lishers, 2nd Edition, 2014.

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EI-308	Digital Signal Processing	L	T	P	C
		3	1	0	4

Pre-requisite – Signals and System

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

UNIT II : Discrete Time System Analysis
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 III : 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 IV : 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 V : Multirate Signal Processing
Introduction to multirate digital signal processing, sampling rate conversion, filter structures, multistage decimator and interpolators, digital filter banks.

UNIT VI: Introduction to DSP Processors
Introduction to DSP Architecture-Harvard architecture- Overview of architecture and instruction set of TMS320C5X

Text books:

1. Digital Signal Processing Principles, Algorithms and Applications: Proakis and Manolakis, PHI, 3rd Edition, 2000.
2. Digital Signal Processor Architecture, Programming and Application: B.Venkataramani & M. Bhaskar, TMH 2002.

Reference Books:

1. Digital Signal Processing: A computer based approach: Mitra, Tata McGraw-Hill, 1998, New Delhi.
2. Discrete-time Signal Processing: Oppenheim and Schafer, PHI, 2nd Edition 2000.

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EI-315	Instrumentation Lab	L	T	P	C
		0	0	3	2

Pre-requisite – Sensor and Transducers and Industrial Instrumentation-I

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 Acqusition using different DAQs and LabVIEW programming.

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EI-316 Industrial Process Control and Automation Lab

L	T	P	C
0	0	3	2

Pre-requisite – Process Control Engg

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

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EI-317 Digital Signal Processing Lab

L	T	P	C
0	0	3	2

Pre-requisite – DSP

1. To represent basic signals (unit step, unit impulse, ramp, exponential l, sine and cosine)
2. Response of discrete-time systems for test inputs.
3. a) addition, b) subtraction c) shifting d)multiplication, and e) convolution
4. To develop program for discrete convolution and discrete correlation
5. To understand stability test
6. To understand sampling theorem
7. To design Analog filters (low-pass, high – pass, band –pass, band -stop)
8. To design digital IIR filters(low-pass, high-pass, band-pass, band-stop)
9. To design FIR filters using windows technique
10. To design a program to compare direct realization values of IIR digital filter

11. To develop a program for computing parallel realization values of IIR digital filter
12. To develop a program for computing cascade realization values of IIR digital filter
13. To develop a program for computing inverse Z-transform of a rational transfer function
14. Design of digital filters-Butterworth and Chebyshev
15. Obtaining DTFT and DFT
16. Assembly-level/High-level language program for the following operations on discrete-time signals
17. Assembly-level/High-level language program for convolution using overlap add/overlap save method
18. Assembly-level/High-level language program for FFT Computation
19. Interfacing of on chip peripherals with a DSP kit
20. (a) FIR filter design using a DSP kit ; (b) IIR Filter Design using a DSP kit.
21. HDL Code: Analyzing & Simulation of basic digital circuits: Adder, Flip-flops, Multiplexer, etc.)
22. Simulation of State machine model, Binary to Excess-3 converter
23. Synthesis: using FPGA/CPLD (Example: Xlinix, Altera, etc) (2 Experiments)
24. To study operation of Tuned RF amplifier and plot the frequency response.
25. To find the modulation index of an AM Wave.
26. To find the demodulation of an AM Wave,and also find the modulating frequency.
27. To study the frequency response of the intermediate frequency transforms (IFT).

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EI-318 Simulation, Design & Fabrication Lab

L	T	P	C
0	0	3	2

Pre-requisite – Digital Electronics, Analog Electronics, Sensors, VI, MATLAB

- Modeling and Functional Simulation of the following digital circuits (with Xilinx/ ModelSim tools) using VHDL/Verilog Hardware Description Languages
- Simulation and design using MATLAB, LabVIEW
- Simulation and design of instruments, process plant and sensors.

Part – I

1. Combinational Logic: Basic Gates, Universal Gates, Adder/ Substractor.
2. Decoders, Address decoders, Comparator Multiplexer.
3. Multipliers, parity generator, ALU.

Part – II

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.

Part – III

7. Memories and State Machines: Read Only Memory (ROM), Random Access Memory (RAM).
8. Mealy State Machine, Moore State Machine, Arithmetic Multipliers using FSMs.

Part-IV:

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

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7TH SEMESTER

		L	T	P	C
EI-401	**Analytical and Optical Instrumentation**	**3**	**1**	**0**	**4**

Pre-requisite – None

Unit I: 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 II: 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 III: 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 IV: 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 V: Optical Instrumentation: Principle of Optical fiber - Numerical aperture - Types of optical fibers - Optical sources. Optical detectors - Fibre optic sensors - Different types of modulators – Industrial application of optical fibres: Measurement of pressure, temperature, current, voltage, liquid level and strain. Interferometers - Interference filters - Optical spectrum analyser - Lasers - Population inversion - Semiconductor lasers - Laser Doppler Anemometry - Medical application of lasers.

Text Books:

1. Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2003.
2. Bella. G, Liptak,"Process Measurement and analysis", CRC press LLC.,2003.
3. H.H. Willard, L.L. Merritt, J.A. Dean, and F.A. Settle, "Instrumental Methods of Analysis", CBS Publishing and Distribution.

Reference Books:

1. Francis Rousseau and Annick Rouesssac, "Chemical analysis Modern Instrumentation Methods & Techniques", John Wiley & sons Ltd., 2007.
2. James W. Robinson ,"Undergraduate Instrumental Analysis", Marcel Dekker.,2005.
3. G.W. Ewing, "Instrumental Methods of Analysis", McGraw Hill.

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ELECTIVE-I

(6th Semester)

		L	T	P	C
EI-321	**IC and VLSI Design**	**3**	**1**	**0**	**4**

Pre-requisite – Basic Electronics

UNIT I

Introduction IC Technology, IC design flow, MOSFET characteristics, parameters and models. MOSFET as diode, capacitor, switch etc.

UNIT II

Single stage amplifiers - CS, CG, Source follower, Cascode stage, frequency response of circuits. Current Mirror, CMOS Differential pair. Negative feedback, Feedback amplifiers, Op-amp - Two-stage op-amp and frequency compensation.

UNIT III

NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, transfer characteristics, noise margin. Logic Families - NMOS, PMOS, CMOS, Pass transistor, TGL, Domino CMOS and Dynamic CMOS logic. Sequential logic circuits.

UNIT IV

Gate realization using CMOS, Introduction to Reconfigurable Hardware – HDL basics. VLSI Design Flow, Different levels of circuit abstraction, Introduction to ASIC and FPGA.

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. J. M. Rabaey, A. Chandrakasan and B. Nikolic, *Digital Integrated Circuits: A Design Perspective*, Second Edition, Pearson/PH, 2003.

REFERENCE BOOKS

1. J. P. Uyemura, *Introduction to VLSI Circuits and Systems*, Wiley, 2001.
2. W.Wolf, *Modern VLSI Design: Systems-on-Chip Design*, Third Edition, Pearson/PH, 2002.
3. R. L. Geiger, P. E. Allen and N. R. Strader, *VLSI Design Techniques for Analog and Digital Circuits*, McGraw-Hill, 1990.
4. 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.

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EI-322 **Power Plant Instrumentation**

L	T	P	C
3	1	0	4

Pre-requisite – Instrumentation-I, II; and Process Control Engineering

- 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.
- 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.
- 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.
- Nonconventional power generation:
- Solar; wind; fuel cell etc.
- Environmental concerns on various types of power plants: thermal; nuclear; wind; hydro; solar etc.

Text Book:

1. Power Plant Instrumentation, K. Krishnaswamy, Pearson.
2. Power Plant Engineering, Samsher Gautam, Vikas Publishing House Pvt. Ltd.
3. Bansal, Kleeman & Melisa - "Renewable Energy Sources & Conversion Technology" - TMH New Delhi.

Reference Book:

1. B. G. Liptak, "Instrumentation in Process Industries,"Chilton Book Co., 1973.
2. Power Plant Engineering, P. K. Nag, Tata McGraw-Hill.
3. Non-Conventional Energy Sources – G. D. Rai

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EI-323 **Computer Networks**

L	T	P	C
3	1	0	4

Pre-requisite – Introduction to Computer Programming

UNIT I: 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 II: 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 III: 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 IV: 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 V: APPLICATION LAYER
Domain Name Space (DNS) – SMTP – FTP – HTTP - WWW – Security – Cryptography.

TEXT BOOKS:
1. Behrouz A. Forouzan, "Data communication and Networking", Tata McGraw- Hill.
2. Andrew S. Tanenbaum, "Computer Networks", PHI, Fourth Edition.
REFERENCES:
1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Pearson Education, 2003.
2. Larry L.Peterson and Peter S. Davie, "Computer Networks", Harcourt Asia Pvt. Ltd., Second Edition.

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EI-324 **PC Based Instrumentation**

L	T	P	C
3	1	0	4

Pre-requisite –Analog Electronics, Digital Electronics, Control System-I

UNIT I
Introduction, Necessity and functions of computers. Level of automation and economy of computer control. Centralized computer control Vs distributed computer control.
UNIT II
Computer architecture, Micro and mini-computer, functional models of I.O. system ,interfacing, Sampling
UNIT III
Multiplexing; A/D and D/A converters, interfacing with different types of transducers - Analog / Digital, Electrical and non electrical selection of sensors; Micro computer interfacing standard buses Serial buses; Serial data communication protocols.
UNIT IV
Study of automatic process control, Fundamental of automatic process control, building block of automatic system, direct and distributed digital control system. Programmable controllers.
UNIT V
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 VI
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. Computer based industrial control: Krishan Kant, PHI.
2. PC-based Instrumentation: Concepts And Practice (Paperback), N. Mathivanan, PHI

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EI-325 **Electro-Magnetic Field Theory**

L	T	P	C
3	1	0	4

Pre-requisite – None

UNIT I 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 II 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.

Maxell'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 III 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 IV 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 V APPLIED ELECTROMAGNETICS - I

Poisson's and Laplace's eqns. Solution of one dimensional cases. General solution of Laplace's eqn. Method of images.

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

REFERENCES:

1. David J.Griffith, 'Introduction to Electrodynamics', Prentice Hall of India Pvt Ltd., New Delhi, Second Edition, 1997.
2. Richard E.Dubroff, S.V.Marshall, G.G.Skitek, 'Electromagnetic Concepts and Applications', Fourth Edition, Prentice Hall of India Pvt Ltd., New Delhi, 1996.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw–Hill International Editions, Fifth Edition, 1999.

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EI-326 **Smart Sensors**

L	T	P	C
3	1	0	4

Pre-requisite –Sensors and Transducers

UNIT – I

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 - II

SENSOR INFORMATION TO MCU: Introduction, amplification and signal conditioning, separate versus integrated signal conditioning, digital conversion.

UNIT - III

MCUS AND DSPS TO INCREASE SENSOR IQ: Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

UNIT - IV

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 - V

CONTROL TECHNIQUES: Introduction, state machines, fuzzy logic, neural networks, combined fuzzy logic and neural networks, adaptive control, other control areas.

UNIT - VI

SENSOR COMMUNICATION & MEMS: Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Microoptics, microgrippers, microprobes, micromirrors, FEDs.

UNIT - VII

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 - VIII

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. Smart Sensors and Sensing Technology, Daniel E. Suarez,Nova Science Publishers

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EI-327	Optimization Techniques	L	T	P	C
		3	1	0	4

Pre-requisite – None

UNIT I :
Introduction to Optimization –statement of optimization problems, engineering applications-classical optimization techniques-single and multivariable objective function with and without constraints.

UNIT II:
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 III
Non-linear programming- one dimensional search, unconstrained optimization tech-gradient approach, steepest descent method, constrained problem- penalty function method, Lagrangian method.

UNIT IV
Dynamic programming- multistage decision process, principle of optimality, computational procedure in Dynamic programming.

UNIT V
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, 11th Edition, 2003.
2. Rao,S.S., "*Optimization: Theory and Applications*", Wiley Eastern.
3. David E. Goldberg, "*Genetic Algorithms in Search, Optimization & Machine Learning* ", Addison Wesley Publishing Company, Inc.

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OPEN ELECTIVE-I

(6th Semester)

EI-331	Air Pollution and Environmental Instrumentation	L	T	P	C
		3	1	0	4

Pre-requisite –None

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.

Air pollution control methods and equipment:
basics of fluid properties, cleaning of gaseous effluents, particulate emission equipments and control, particulate collector selection and gaseous emission control. Specific gaseous pollutants analysis and control.

Water pollution:
its sources and classification, wastewater sampling and analysis, wastewater treatment. Solid waste management and Hazardous waste management.

Sound pollution:
basics of sound pollution, its effect to environment. Acoustic noise measurement, monitoring and control.

Books:

1. Understanding Environmental Pollution by Marquita K. Hill, 2010
2. Air Pollution Control: Fundamentals and Applications (Fundamentals of Environmental Engineering) 1st Edition, Kindle Edition, by Jeff Kuo (2018)

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EI-332 **Opto-electronics and Fiber Optics**

L	T	P	C
3	1	0	4

Pre-requisite – None

UNIT I

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 II

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 III

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 IV

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. Optical Fiber Communication by Gerd Keiser, McGraw Hill International Edition.
2. Fiber Optics and Opto electronics by R. P. Khare, Oxford University Press .

Reference Book :

1. Optical Fiber Communications Principles and Practice by John M. Senior, Pearson Education.
2. Optoelectronics and Fiber Optics Communication by C.K.Sarkar and D.C Sarkar, New Age International.

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EI-333 **Digital Image Processing**

L	T	P	C
3	1	0	4

Pre-requisite –Digital Signal Processing

UNIT I

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 II

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 III

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 IV

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 V

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. Digital image Processing: I.Gonzalez Rafel C, Pearson Education.

REFERENCES:
1. Fundamentals of digital image processing: Jain Anil K, PHI.
2. Digital Image Processing: Pratt William K, John Wiley.

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EI-334 **Wind and Solar based System**

L	T	P	C
3	1	0	4

Pre-requisite – None

UNIT I: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 II: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 III: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.

Books:
1. G D Rai, “Solar Energy Utilization”, Khanna Publishers.
2. S.P Sukhatme, “Solar Energy -Principles of Thermal Collection and Storage”, Tata McGraw-Hill.
3. F Kreith, and J.F Kreider, “Principles of Solar Engineering”, Mc-Graw-Hill Book Co.
4. J. F. Manwell, J. G. McGowan, A. L. Rogers, “Wind Energy Explained”, John Weily & Sons Ltd,
5. S A Abbasi, “Renewable energy sources and their environmental impact”, Prentice hall of India.

Reference Books:
1. A.Duffie and W.A.Beckmann, Solar Engineering of Thermal Processes-John Wiley .
2. F.Kreith and J.F.Kreider, Principles of Solar Engineering , McGraw-Hill.
3. T.N.Veziroglu, Alternative Energy Sources, Vol 5 and 6, McGraw-Hill.
4. E.J. Womack , “MHD power generation engineering aspects” , Chapman, Hall Publication.

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EI-335 **Soft Computing Techniques and Applications**

L	T	P	C
3	1	0	4

Pre-requisite – None

UNIT I
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 II

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 III

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 IV

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. R. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications*, Prentice Hall of India, New Delhi, 2003.
2. L. Fausett, *Fundamentals of Neural Networks*, Prentice Hall, Upper Saddle River, N.J, 1994.

Reference Books

1. D. E. Goldberg, *Genetic Algorithms in Search, Optimisation, and Machine Learning*, Addison- Wesley, Reading, MA, 1989.
2. M. T. Hagan, H. B. Demuth, and M. H. Beale, *Neural Network Design*, PWS Publishing, Boston, MA, 1996.
3. T. Ross, Fuzzy Logic with Engineering Applications, Tata McGraw Hill, New Delhi, 1995.
4. J. R. Koza, *Genetic Programming: On the Programming of Computers by Natural Selection*, MIT Press, Cambridge, 1992.
5. B. Yegnanarayana, *Artificial Neural Networks*. Prentice Hall of India, New Delhi, 1999.

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EI-336 **Wireless Sensor Networks**

L	T	P	C
3	1	0	4

Pre-requisite – Communication and Telemetry

Characteristics Of WSN: Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc 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.

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.

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.

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.

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. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.
2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

REFERENCE BOOKS :

1. K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325—349
2. Philip Levis, " TinyOS Programming" 3.Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd.

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EI-337 **Logic and Distributed Control**

L	T	P	C
3	1	0	4

Pre-requisite – Control system-I

Unit I

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 II

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 III

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 IV

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 V

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

REFERENCES

1. Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, NewYork, 1995.
2. Curtis D. Johnson, Process Control Instrumentation Technology, Fourth edition, PHI

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ELECTIVE-II

(7th Semester)

		L	T	P	C
EI-421	**Advanced Instrumentation**	**3**	**1**	**0**	**4**

Pre-requisite –Sensors, Industrial Instrumentation-I , Sensors & Transducers

UNIT I

Introduction, Instrumentation-Functional elements of an instrumentation system-Data acquisition systems-DAS; Sensors & transducers, emerging fields, types of sensors, their parameters.

UNIT II

Microelectronic and micro electro-mechanical systems, Primary sensing principles and measurement variables, Sensor performance characteristics and terminology.

Transducer measurement circuits, Signal conditioning circuits, Sensor data acquirement. Basic principles of the acquirement and transmission of the data; Fibre-optic sensors-types, working, applications.

Bio-medical Instrumentation; Selection of Transducers and Electrodes, Transmission and reception aspects of Bio-Medical signals.

UNIT III

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

UNIT IV

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;

UNIT V

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.

Real World Interfacing – LCD, ADC, Sensors, Stepper motor, keyboard and DAC, USB interfacing, etc.

TEXT BOOKS:

1. I. R. Sinclair, Sensors and Transducers, John Wiley & Sons.

REFERENCE BOOKS:

1. J. R. Brauer, Magnetic Actuators and Sensors, Wiley-IEEE Press.
2. D. Patranabis, Sensors and Transducers, PHI, New Delhi
3. Barney, G.C., Intelligent instruments, Hemel Hempsteao: Prentice Hall.
4. ALAN S. Morris, Principles of Measurement & Instrumentation. New Delhi, PHI Pvt. Ltd.

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		L	T	P	C
EI-422	**Biomedical Signal Processing**	**3**	**1**	**0**	**4**

Pre-requisite – Basic Signal Processing

UNIT I

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 II

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 III

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 IV

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 V

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. Rangaraj M. Rangayyan " Biomedical Signal Analysis". IEEE Press, 2001.
2. D.C.Reddy, Biomedical Signal Processing- principles and techniques, Tata McGraw-Hill.
3. Biomedical Digital Signal Processing, Willis J.Tompkins, PHI.

REFERENCE BOOKS:

1. Weitkunat R, Digital Bio signal Processing, Elsevier.
2. Akay M , Biomedical Signal Processing, Academic: Press.
3. Cohen.A, Biomedical Signal Processing -Vol. I Time & Frequency Analysis, CRC Press.

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EI-423	Real Time Embedded Systems	L	T	P	C
		3	1	0	4

Pre-requisite –Digital Electronics, Microprocessors & microcontrollers

UNIT I: 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 II: 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 III: 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 IV: MODELLING RTS

Event based, Process based and graph based models, petrinet 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 V: CASE STUDIES

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

TEXT BOOKS:

1. Ball. S.R, Embedded microprocessor Systems: Real world Design, Prentice Hall, 1996
2. Herma. K., Real Time Systems: Design for distribution embedded applications, Kluwer Academic 1997.
3. Krishna C.M., Real Time systems , Mc-Graw-Hill Singapore,1998.
4. Rajkamal, *Embedded Systems Architecture Programming and Design*, McGraw Hill, Second Edition.

REFERENCE BOOKS:
1. Levi S. and Agarwala A.K., Real- Time System Design , Mc-Graw-Hill, NewYork,1990.
2. Laplante P.A., Real- Time Systems Design and Analysis , EEE Press, NewYork, 1992
3. Stuart Bennett, Real-time Computer Control , Prentice Hall, London,1998.
4. Gassle J., Art of Programming Embedded syste
5. ms, Academic Press 1992

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EI-424	IoT based Instrumentation	L	T	P	C
		3	1	0	4

Pre-requisite – Sensors & Transducers, Basic Signal Processing.

UNIT I –INTRODUCTION
Internet of Things Promises–Definition–Scope–Sensors for IoT Applications–Structure of IoT–IoT Map Device

UNIT II -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 III -TECHNOLOGICAL ANALYSIS
Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module

UNIT IV -IOT DEVELOPMENT EXAMPLES
ACOEM Eagle –EnOcean Push Button –NEST Sensor –Ninja Blocks -Focus on Wearable Electronics

UNIT V -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

REFERENCES
1. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014
2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
3. Editors OvidiuVermesan Peter Friess,'Internet of Things –From Research and Innovation to Market
4. River Publishers, 20145 .N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014

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EI-425	MEMS & Nanotechnology	L	T	P	C
		3	1	0	4

Pre-requisite – Analog Electronics

UNIT I : 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 II : 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 III : 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 IV : 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 V : Basics of Nanotechnology
Basics and scale of nanotechnology, different classes of nanomaterials, synthesis of nanomaterials, fabrication and characterization of nanostructures, applications.

Text Books:

1. Micro Electro Mechanical System Design, James J. Allen - CRC Press.
2. Introduction to Microelectromechanical Systems Engineering by Nadeem.
3. Introduction to Nanotechnology by Charles P. Poole Jr., Frank J. Owens, John Wiley & Sons Publications, 2003.

Reference Books:

1. "MEMS and nanotechnology based sensors and devices for communications medical and Aerospace applications", Jha A. R. - CRC Publications.
2. "MEMS Design and fabrication" Mohamed Gad-El-Hak – CRC Press.
3. "MEMS : A Practical Guide to Design, Analysis and Applications" Jan G Korvink, Oliver Paul – Springer-Verlag.
4. MEMS & MOEMS Technology and Applications- P. Rai Choudhury

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EI-426 Non Linear Control Systems

L	T	P	C
3	1	0	4

Pre-requisite – Control system-I & II

UNIT I : 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 II : Planar dynamical systems
Phase plane techniques, limit cycles, Poincare-Bendixson theorem, multiple equilibria, index theory, bifurcations (fold, pitch, fork, Hopf, saddle connection)

UNIT III : 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 IV : Lyapunov stability
Definitions of (in) stability, basic (in) stability theorems, converse Lyapunov theorems, LaSalle Invariance Principle, exponential stability theorems, linear systems, feedback stabilization.

UNIT V : 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 VI : Input-output stability
Definitions of input-output stability, small gain theorems, passivity, passivity theorems, describing functions, harmonic balance, connections with state space stability.

UNIT VII : Introduction to sliding mode control

Introduction to Sliding Mode, Classical Sliding Mode Control and Observation

TEXT BOOKS:

1. H. K. Khalil, "Nonlinear Systems", Prentice Hall, Englewood Cli_s, NJ, third edition.
2. S. S. Sastry. Nonlinear Systems: Analysis, Stability and Control. Interdisciplinary Applied Mathematics. Springer Verlag, New York.

REFERENCES:

1. H. Nijmeijer and A. J. van der Schaft, "Nonlinear Dynamical Control Systems", Springer Verlag, NewYork.
2. A. Isidori. Nonlinear Control Systems. Springer Verlag, New York.
3. E. D. Sontag. Mathematical Control Theory: Deterministic Finite Dimensional Systems, volume 6 of TAM.SpringerVerlag, New York.

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EI-427	**Linear Integrated Circuits**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite –Analog Electronics

Unit I: 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 Ii: 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 III 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 IV: 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 V: Waveform Generators And Special Functionics

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. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2007.

References:

1. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2001.
2. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.
3. B.S.Sonde, "System design using Integrated Circuits" , 2nd Edition, New Age Pub, 2001
4. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International, 2005.
5. Michael Jacob, "Applications and Design with Analog Integrated Circuits", Prentice Hall of India,1996.

6. William D.Stanley, "Operational Amplifiers with Linear Integrated Circuits", Pearson Education,2004.
7. S.Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", TMH, 2008.

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OPEN ELECTIVE-II

(7th Semester)

		L	T	P	C
EI-431	**Robotics and Automation**	**3**	**0**	**0**	**3**

Pre-requisite – Sensors and Transducers, Control theory

Unit I: Introduction: overview of a robotic system, applications and significance of a robotic system, elements of a robotic system, future advances in robotics.

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

Unit III: 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 IV: Control design: basics of a control system – closed loop and open loop, feedback and feedforward control, PID controller. PLC programming and ladder logic, analog input output, microprocessor applications in mechatronics, programming interfacing.

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

Text Books:

1. Mikell Groover, "Industrial Robotics: Technology, Programming, and Applications", 2nd edition, Tata McGraw-Hill
2. Devdas Shetty & Richard Kolk "Mechatronics System Design", 3rd edition. PWS Publishing, 2009.
3. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Dynamics and Control", 2nd edition, 2004.

Reference Books:

1. Oussama Khatib, "Handbook of Robotics", Springer, 2008.

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		L	T	P	C
EI-432	**Instrumentation in Petrochemical Industry**	**3**	**0**	**0**	**3**

Pre-requisite – None

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

2. CHEMICALS FROM PETROLEUM PRODUCTS

Chemicals from petroleum -Methane derivatives- Acetylene derivatives- Ethylene derivatives- Propylene derivatives - Cyclic petrochemicals - Other Products

3. UNIT OPERATIONS IN PETROCHEMICAL INDUSTRY

Important unit operations-Drying-Separation-Heat transfer-Distillation-Thermal crackingcatalytic cracking-catalytic reforming- hydro cracking – hydro treating -Chemical oxidation-Chemical reduction-Polymerisation-Alkylation-ISomerization-Production of Ethylene, Acetylene- and propylene from petroleum

4. MODELLING OF PETROCHEMICAL PROCESSES

Modelling of refinery reactors - Dynamic modeling of catalytic cracking unit – catalytic reformer – modeling of crude distillation units – main fractionators.

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 .J.G. and Mumme K.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.

REFERENCES

1. Austin G.T. Shreeves, Chemical Process Industries, McGraw-Hill International student edition, Singapore, 1985.
2. Liptak B.G. Instrumentation in process industries, Chilton book Company, 1994.
3. Liptak B.G., Process measurement and analysis, Third edition, Chilton book Company, 1996.

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EI-433 Neural Networks and Fuzzy Logic

L	T	P	C
3	0	0	3

Pre-requisite – None

UNIT I : 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 modeling.

UNIT II: 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 III: FUZZY LOGIC

Introduction to fuzzy logic system, fuzzy sets, membership function, linguistic variables, rules and algorithm, fuzzy relations.

UNIT IV: 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 V: 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. Laurance Fausett, “Fundamentals of Neural Networks”, Prentice Hall, Englewood cliffs, N.J, 1992.
2. H.J Zimmermann, “Fuzzy set theory and its applications”, Allied Publication Ltd.
3. G.J Klir.and B.B Yuan, “Fuzzy sets and fuzzy logic”, Prentice Hall of India, New Delhi.
4. D Driankov, H Hellendron, M Reinfrank., “An Introduction to Fuzzy control”, Narosa publishing House, New Delhi.

5. W.T. Millon, R.S. Sutton and P.J. Webrose, “Neural Networks for control”, MIT Press.

REFERENCES:

1. L.H Tsoukalas, and E.Uhrig , “Robert, Fuzzy and Neural approach in Engineering”, John Wiley and Sons.
2. M.Zurada Jacek, “ Introduction to artificial Neural Systems”, Jaico Publishing House, Mumbai

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EI-434	Renewable Energy Systems	L	T	P	C
		3	0	0	3

Pre-requisite –None

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.

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.

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.

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

Case Study
Simulation of a single or hybrid renewable energy system.

Books:

1. "Renewable Energy Sources & Conversion Technology," by Bansal, Kleeman & Melisa – Tata McGraw Hill.
2. “Solar Energy,” by S. P. Sukhatme.
4. “Non-Conventional Energy Sources,” by G. D. Rai

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EI-435	Machine Learning	L	T	P	C
		3	0	0	3

Pre-requisite – Digital Signal Processing

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.

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.

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.

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.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning.
4. Mitchell T. M. , Machine Learning (McGraw Hill).

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EI-436 Probability and Random Processes

L	T	P	C
3	0	0	3

Pre-requisite – Signals and Systems

UNIT I: 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 II: 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 III: 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 IV: Random Process

Random process: realizations, sample paths, discrete and continuous time processes, examples; Probabilistic structure of a random process; mean, autocorrelation and autocovariance 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. Probability, Random Variables, and Stochastic Processes. Papoulis, S. U. Pillai, McGraw Hill 2001.

Reference Books:

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

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EI-437 **Human Computer Interfaces**

L	T	P	C
3	0	0	3

Pre-requisite – None

UNIT I : **Introduction:**
Importance of user Interface – Definition, Importance of good design, Benefits of good design, A brief history of Screen design.
UNIT II: 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 III: Design process:
Human interaction with computers, Importance of human characteristics human consideration, Human interaction speeds, Understanding business junctions.
UNIT IV: 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 V: 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. The essential guide to user interface design Wilbert O Galitz Wiley DreamTech
2. Designing the user interface. 3rd Edition Ben Shneidermann Pearson Education, Asia

Reference Books:

1. Human – Computer Interaction. Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg, Pearson Education.
2. Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech.
3. User Interface Design, Soren Lauesen , Pearson Education.

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EI-438 **Mobile Adhoc and Sensor Networks**

L	T	P	C
3	0	0	3

Pre-requisite – Communication & Telemetry

UNIT I
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 II
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 III
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 IV
Simulation and Modeling of Wireless, Mobile, and Ad Hoc Networks, Modeling Cross-Layering Interaction Using Inverse Optimization Algorithmic Challenges in Ad Hoc Networks

UNIT V: 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.

Books:

1. Mobile Adhoc Networks – Aggelou , George (McGraw-Hill).
2. Mobile Adhoc Networking – Stefano Basagni (Editor), Marco Conti (Editor), Silvia Giordano (Editor), Ivan Stojmenovi & Cacute (Editor) (Wiley-IEEE Press).
3. The course mainly based on contemporary research on sensor network and ubiquitous computing. Papers from leading journals need to be consulted.
4. Wireless Sensor Networks: An Information Processing Approach – Feng Zhao, Leonidas Guibas (Elsevier).
5. Handbook of Sensor Networks: Algorithms and Architectures – Ivan Stojmenovi & Cacute (Wiley).
   (The course mainly based on contemporary research on sensor network and ubiquitous computing. Papers from leading journals need to be consulted.)

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EI-439 Aquaponics Monitoring and Control

L	T	P	C
3	0	0	3

Pre-requisite – Process control, Sensors and Transducers, Industrial Instrumentation.

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 Aquaponics cycle. Advantages, limitations and disadvantages of aquaponics systems.

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.

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.

Control parameters of aquaponics system.

Sensors for Water levels, Temperature, pH, Humidity, Light, Oxygen, Nitrogen and Ammonia contents in water, E.coli levels, Fish feed set point.

Automation in aquaponics,

Need of control in aquaponics system, Different types of control schemes: Cascade control scheme, Distributed control scheme, Model predictive control scheme. Practical implementation and human machine interface.

Books:

1. Seborg Dale, Thomas Edgar, and Duncan Mellichamp. Process Dynamics and Control. Wiley, 2nd Edition, 2003, ISBN: 978-0471000778.
2. Zhang, Qin, and Francis J. Pierce. Agricultural automation: fundamentals and practices. CRC Press, 2016.
3. Spedding, C. An introduction to agricultural systems. Springer Science & Business Media, 2012.

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ELECTIVE-III

(8th SEMESTER)

EI-441 **Advanced Sensors and Signal Processing**

L	T	P	C
3	1	0	4

Pre-requisite – Sensors and Transducers, Digital Signal Processing

Unit: I
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 II
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 III
High impedance sensors: Photodiodes and high impedance charge output sensors, Signal conditioning of high impedance sensors

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

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

Unit VI
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.

REFERENCES:

1. H.K.P Neubert "Instrument Transducers Oxford Herman University Press Eighth Impression 2008.
2. Ramon Pallas-Arenyand Johan G. Webster "Sensor And Signal Conditioning" John Wiley,
3. New York 1991.
4. Dan Sheingold-Editior "Transducer Interfacing Handbook", Analog Devices Inc 1980
5. "High Speed Design Technique" Analog Device Inc 1996
6. Jacoba Fraden "Handbook Of Modern Sensors "2nd Edition ,Springer-Verlag.New York 1996
7. Jerald G.Graeme "Photodiode Amplifiers And Op-Amp Solution", Mc Graw Hill 1995
8. Harry L. Trietly , "Transducers In Mechanical And Electronic Design", Marcel Dekker Inc 1986

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EI-442 **Piping and Instrumentation**

L	T	P	C
3	1	0	4

Pre-requisite – None

Introduction- Significance of piping- Industry oriented piping-P&I Diagram objectives. Industry Codes and Standards. Government regulations.

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

Piping components : Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socket welded 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.

Process plant equipments/ mechanical equipments : 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.

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.

Process & instrumentation diagrams (P&ID)/ process flow diagram (PFD) : Purpose of P&ID¨S, study of P&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.

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

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

Standard piping details/ piping system : Pipe Rack Spacing, Drawing pipe in the rack, pipe insulation shoes, pipe guides, field supports, dummy supports, hanger rods, spring hangers, pick-up pipe supports, plant utilities, control valve manifolds, utility stations, sewer and under ground piping system.

[Laboratory: Students are required to practice & produce P&I diagrams using software packages in laboratory during the period of the course.]

References:

1. *Industry Codes and Standards*
2. American National Standards Institute (ANSI) - ANSI/FCI 70-2-2003 - Control Valve Seat Leakage
3. American Society of Mechanical Engineers (ASME) - ASME Boiler and Pressure Vessel Code. Section VIII - Pressure Vessels
4. The Instrumentation, Systems and Automation Society (ISA)
5. ISA 5.1 - Instrumentation Symbols and Identification
6. ISA 5.2 - Binary Logic Diagrams for Process Operations
7. ISA 5.3 - Graphic Symbols for Distributed Control/ Shared Display *Instrumentation, Logic and Computer Systems*
8. ISA 84.01 - Application of Safety Instrumented Systems for the Process Industries
9. Tubular Exchanger Manufacturers Association (TEMA) - TEMA Standards
10. *Government Regulations*
11. Occupational Safety and Health Administration (OSHA) - OSHA 29 CFR 1910.119 - Occupational Safety and Health Standards, Process Safety Management of Highly Hazardous Chemicals.

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EI-443 Industrial Automation

L	T	P	C
3	1	0	4

Pre-requisite – Process Control Engg

Unit I

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 II

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 III

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 IV

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 V

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 VI

Automation for following industries – Power, Water and Waste Water Treatment, Food and Beverages, Cement, Pharmaceuticals, Automobile and Building Automation

Text Books:

1. Distributed Computer Control for Industrial Automation by Poppovik Bhatkar, Dekkar Publications
2. Programmable Logic Controllers: Principles and Applications by Webb and Reis PHI
3. Computer Aided Process Control, by S.K.Singh PHI

Reference books:

1. Introduction to Programmable Logic Controllers, by Garry Dunning Thomson
Learning.
2. The Management of Control System: Justification and Technical Auditing
N.E.Battikha ISA
3. Computer Based Process Control Krishna Kant PH

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EI-444 Wireless Communication

L	T	P	C
3	1	0	4

Pre-requisite – Communication and Telemetry

UNIT I : 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 II : 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 III : **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 IV: Mobile Radio Propagation: Large Scale PathLoss

Introduction to radio wave propagation, free-space propagation model, basic propagation schemes, pathloss model, outdoor propagation model-Okamura and Hata Model.

UNIT V: 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 VI : 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 VII : Intelligent Cell Concept and Application

Intelligent cell concept, applications of intelligent micro-cell Systems, in-Building Communication, CDMA cellular Radio Networks.

TEXT BOOKS:

1. Wireless Communications: Theodore S. Rappaport; Pearsons.
2. Mobile Cellular Telecommunication: W.C.Y.Lee; McGraw Hill.

REFERENCE BOOK:

1. Mobile Communications: Jochen Schiller; Pearson.

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		L	T	P	C
EI-445	**Adaptive Control**	**3**	**1**	**0**	**4**

Pre-requisite – Nonlinear Control

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

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.

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.

Adaptive observers for linear systems. Systems in adaptive observer form. Filtered transformations.

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.

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

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

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

Selected topics. The adaptive regulator problem. Adaptive internal model design

References:

1. P. Ioannou and B Fidan, Adaptive Control Tutorial, SIAM, 2006 http://www.siam.org/books/dc11/
2. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989
3. S. Sastry and M. Bodson, Adaptive Control, Prentice- Hall, 1989 (available at http://www.ece.utah.edu/%7Ebodson/acscr/index.ht ml)
4. A. Isidori, L. Marconi, and A. Serrani, *Robust Autonomous Guidance. An Internal Model Approach*. Springer-Verlag, 2003.

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		L	T	P	C
EI-446	**Analog Integrated Circuit Design**	**3**	**1**	**0**	**4**

Pre-requisite – Analog Electronics

UNIT I

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

UNIT II
Current mirrors, Biasing and references, Constant voltage and current references, Voltage regulator.
UNIT III
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 IV
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. Microelectronics Circuits, 5th Edition, International Student Edition Sedra and Smith , Oxford University Press, New Delhi.

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EI-447 **Mechatronics**

L	T	P	C
3	1	0	4

Pre-requisite – None

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

Unit II: Modeling 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 III: Sensors and Transducers: tachometers, proximity and range sensors, accelerometers, gyroscopes, SONAR and RADAR, vision sensor, encoders and resolvers.

Unit IV: 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 V: Control design: basics of a control system – closed loop and open loop

Unit VI: Case study of mechatronic systems: homing of an industrial robot in a remote location using image processing. 5L

Text Books:

3. Mikell Groover, "Industrial Robotics: Technology, Programming, and Applications", 2nd edition, Tata McGraw-Hill
4. Devdas Shetty & Richard Kolk "Mechatronics System Design", 3rd edition. PWS Publishing, 2009.
5. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Dynamics and Control", 2nd edition, 2004.

Web references:
1. https://nptel.ac.in/courses/112103174/

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OPEN ELECTIVE-III

(8th SEMESTER)

		L	T	P	C
EI-451	**Intelligent Instrumentation**	**3**	**0**	**0**	**3**

Pre-requisite – None

UNIT I-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 II- Data Acquisition Methods:
Interfacing methods of DAQ hardware, software structure, use of simple and intermediate 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 III-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 IV- 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 V- 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 Book

1. Barney, G.C., Intelligent instruments, Hemel Hempsteao: Prentice Hall.
2. M. Bhuyan, Intelligent Instrumentation Principles and Applications, CRC Press 2011 ISBN-13: 978-1-4200-8954-7.
3. Lisa,K.Wells &Jeffery Travis / Lab VIEW For every one Prentice Hall,1997.

Reference Book:

1. D.Patranabis, Sensors s Transducers, New Delhi, PHI.
2. Roman Kuc, Introduction to Digital Signal Processing, New York: McGraw-Hill Pub. Co.
3. S. Gupta / P.C Interfacing for data Acquisition & Process Control, 2nd Edition / Instrument Society of America, 1994.
4. ALAN S. Morris, Principles of Measurement s Instrumentation. New Delhi, PHI Pvt. Ltd.

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		L	T	P	C
EI-452	**Advanced Process Control**	**3**	**0**	**0**	**3**

Pre-requisite –Introductory course in Control System.
MATLAB or similar computational software (For solving assignments).

Review of process control: Need and objectives of process control, Process control hierarchy. Introduction to multivariable control and dis- tributed control. Regulatory control and set-point tracking control. Pro-grammable logic controllers. Need of process model. Distributed control system. Human-machine interface.
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.
Design of feedback controller: ON-OFF control. Modified ON-OFF con- trol. Multi-position control. Proportional control. Effect of integral and derivative action. Proportional-integral control. Proportional-integral-derivative control. Advantages and limitations of various control strate- gies and measures to overcome the limitations. Practical implementation of controllers. Performance criteria for controllers. Tuning of PID con-

trollers (minimum one openloop and one closedloop method).

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

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.

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.

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

Text Books:

1. Seborg Dale, Thomas Edgar, and Duncan Mellichamp. Process Dynamics and Control. Wiley, 2nd Edition, 2003, ISBN: 978-0471000778.
2. Babatunde A. Ogunnaike, and W. Harmon Ray. Process Dynamics, Mod- eling, and Control. Oxford university press, 1994, ISBN: 978-0195091199.
3. B. Wayne Bequette. Process Control: Modeling, Design and Simulation. Prentice Hall, 2003, ISBN: 978-0133536409.
4. W. Luyben. Process Modeling,Simulation and Control. McGraw hill pub- lishers, 2nd Edition, 2014.

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EI-453 **Bio-signal Processing**

L	T	P	C
3	0	0	3

Pre-requisite – Signals and Systems

Sources of Biomedical signals, 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.

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.

ADAPTIVE NOISE CANCELLATION

Introduction, principle of adaptive noise canceling, adaptive Noise cancellation with the LMS and RLS adaptation algorithm - applications – adaptive noise canceling method to enhance ECG monitoring, adaptive noise canceling method to enhance Fetal ECG monitoring, adaptive noise canceling method to enhance Electro gastric measurements.

PARAMETRIC MODELING METHODS

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

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.

REFERENCES

1. M.Akay, 'Biomedical Signal Processing' Academic Press, San Diego, 1994.
2. M.Akay, Nonlinear
Biomedical Signal Processing, Fuzzy Logic, Neural Networks and New
Algorithms (vol1) (IEEE Press series on Biomedical Engineering)
3. Eugene.N. Bruce, 'Biomedical Signal Processing and Signal Modeling', Wiley publications 2000.

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EI-454 Advanced Memory Technology

L	T	P	C
3	0	0	3

Pre-requisite – Electronic Devices, VLSI Systems and Technology

Introduction to memory devices:
Evolution and history; archival data storage; classification of memory technologies, advances in optical memories.
Nonvolatile memories:
Magnetic memories, HDDs; Silicon based thin film transistor nonvolatile memories; Flash memories, classification and operation; challenges; advancements.
Volatile memories:
Random access memories, classification and operation; SRAMs; DRAMs; history and challenges.
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. Tseung-Yuen Tseng and Simon M. Sze, Nonvolatile memories Materials, Devices and Applications, Volume 1 and 2, ISBN: 1-58883-250-3
2. J. Brewer and M. Gill, Nonvolatile memory technologies with emphasis on Flash, IEEE Press series on microelectronic systems, WILEY-INTERSCIENCE 2008, ISBN: 978-0471-77002-2
3. S. Raoux and M. Wuttig, Phase change materials-Science and Applications, Springer 2009, ISBN:978-0-387-84873-0

References:
1. Review article: S. Lai, Flash memories: Successes and challenges, IBM Journal of Res. And Dev. Vol.52, p529, 2008.
2. Review article: H-S. Philip Wong et. al., Phase change memory, Proceedings of the IEEE, Vol.98, p2201, 2010

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EI-455 Introduction to Cyber Physical Systems

L	T	P	C
3	0	0	3

Pre-requisite – Control system-I &II

Unit I — CPS Review & Background: Course introduction & syllabus, prerequisites, major applications, course overview
Unit II — Linear & Nonlinear Networked Systems Theory: Recent relevant theories on linear and nonlinear systems
Unit III — State Observation & Estimation of CPSs: Dynamic state estimation of dynamic CPSs
Unit IV — CPSs & Convex Optimization: Basic principles on convex optimization for generic systems
Unit V — Optimal Control of CPSs: Linear quadratic regulator, optimal state-feedback control, principle of optimality
Unit VI — Networked Control Systems: Recent results on networked control systems, fault detection, cyber-attacks
Unit VII — Applications: Smart-grids, transportation networks, robotics

References:
1. C. T. Chen, Linear System Theory and Design, Oxford University Press, 1995.
2. F. Y. Wang and D. Liu, Networked Control Systems, Theory and Applications, Springer-Verlag London, 2008.
3. E. Lee and S. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition,
4. LeeSeshia.org, 2015. Book available online: http://leeseshia.org/releases/LeeSeshia_ DigitalV2_0.pdf.
5. S. Boyd, L. El Ghaoui, E. Feron and V. Balakrishnan, Linear Matrix Inequalities in System and Control Theory, SIAM, 1994. Book webpage: http://web.stanford.edu/~boyd/lmibook/.
6. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004. YouTube videos for the class: https://www.youtube.com/watch?v=McLq1hEq3UY and book webpage: http: //web.stanford.edu/~boyd/cvxbook/

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EI-456 Optimization Methods in Engineering

L	T	P	C
3	0	0	3

Pre-requisite – None

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

UNIT II :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 III : 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 IV: Integer Programming
Integer linear programming-graphical representation, cutting plane method. Nonlinear programming-Integer polynomial programming.

UNIT V:Non traditional Optimization Algorithm
Genetic Algorithm – Working principle, Difference and similarities between GAs and traditional methods, GAs for constrained optimization.

Reference Books:

1. Optimization Theory and Application, Rao, S.S. New Age
2. Optimization for Engineering Design, Deb, Kalyanmoy, PHI
3. Introduction to Optimum design Arora, Jasbir, S. McGraw Hill
4. Foundations of Optimization, Beighfler, C.S. PHI
5. Optimization methods in Operation Mital, K. V. New Age
6. Research and System Analysis Operation Research Phillip & Ravindran John Wiley & Sons

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EI-457 Information Theory, Cryptography and Security

L	T	P	C
3	0	0	3

Pre-requisite – Communication & Telemetry, Probability

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.
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.
Coding convolutional codes, encoder, generator matrix, transform domain representation state diagram, distance properties, maximum likelihood decoding, Viterbi decoding, sequential decoding, interleaved convolutional codes. Special topics in information theory and coding.
Overview of cryptography, simple classical cryptosystems, cryptanalysis, Perfect secrecy-information theoretic security.

Text Books:

1. R. Bose, Information Theory Coding and Cryptography, Tata McGraw Hill.
2. F. J. MacWilliams, N. J. A. Sloane, The Theory of Error Correcting Codes, Elsevier.
3. Jorge Castiñeira Moreira, Patrick Guy Farrell , Essentials of Error-Control Coding, John Wiley, 2006. ISBN: 978-0-470-02920-6

Reference Books:

1. T. M. Cover, J. A. Thomas, Elements of Information Theory, Wiley, 1991.
2. Dominic Welsh, Codes and Cryptography, Oxford Science Publications, 1988

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EI-458 Modelling and Controlling of Energy Storage Systems

L	T	P	C
3	0	0	3

Pre-requisite –None

Introduction
Need of energy storage; various types of energy storage systems; applications.
Modelling
Working, characteristics, and modelling (electrical/ electrothermal/ electrochemical/ electromechanical) of Battery, supercapacitor, fuel cell, etc.
Estimation
Introduction; Applications; state and parameter estimation of energy storage systems.
Control
Charging and discharging control under various constraints; rule based; optimal.
Case Study
Simulation study on modelling estimation and control of one energy storage system.
Applications- Transportation (electric/hybrid electric vehicle); Wireless sensor network; smart grid.

Study Materials:

1. "Battery Systems Engineering," by C-Y Wang, and C. D. Rahn; Wiley & Sons.
2. "Fuel Cell: Modelling, Control, and Applications," by Beigou, Bill, and Diong; CRC Press.
3. "Electrochemical Energy Storage - Battery and Supercapacitor Set," J. M. Tarascon, and P. Simon; Wiley.
4. "Optimal and Robust Estimation: with an Introduction to Stochastic Theory," Frank Lewis, Lihua Xie, and Dan Popa; CRC Press.
5. "Optimal control," D. S. Naidu, CRC Press.

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EI-459 Aerospace and Navigation Instrumentation

L	T	P	C
3	0	0	3

Pre-requisite –None

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.
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.
Basic engine instruments- Capacitive fuel content- Gauges. Standard atmosphere- Altimeters Aneroid and radio 6 15% altimeters.
Aircraft compass- Remote indicating magnetic compass Rate of climb indicator- Pitot static system- Air speed indicator- Mach meters- Integrated flight instruments
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.
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.

Books:

1. Aircraft Systems: Instruments, Communications, Navigation, and Control, Chris Binns, Wiley-Blackwell (28 December 2018)
2. Spacecraft Navigation and Guidance (Advances in Industrial Control), Maxwell Noton, Springer; (10 December 2011)

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