Bachelor of Instrumentation and Electronics Engineering (Curriculum)

Bachelor of Instrumentation and Electronics Engineering
(Syllabus for 2nd to 4th years)

Course code: FET/BS/B/Math/T/211	**Mathematics-III**	**L T P C** **3 1 0 4**
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122**	
Objectives:	The course aims to provide adequate knowledge about ● Statistical methods in applied sciences ● Vector algebra and calculus and their practical applications ● ODEs and PDEs and their practical applications	
Course Outcomes:	On completion of the course, the students will be able to CO1: Solve problems related to probability, conditional probability, measures of central tendency, measures of dispersion, correlation and regression, discrete and continuous random variables, distribution functions, expectation and variance (K3) CO2: Compute scalar and cross product of vectors in 2 and 3 dimensions and apply in problems of mechanics (K3) CO3: Comprehend vector differentiation and ideas of divergence, curl, and gradient, vector fields and Green' theorem, Gauss Theorem, Stokes' theorem and their applications (K2) CO4: Apply vector integration including line, surface and volume integrals (K3) CO5: Solve ordinary and partial differential equations of first order using classical methods (K3) CO6: Solve linear differential equations and their systems of second order using classical method and comprehend applications to one dimensional wave and diffusion equations and two dimensional Laplace equation.(K3)	
Unit I	**Probability and Statistics: 8L+4T** Definition of probability; Conditional probability and independence; Bayes'theorem; Collection and Representation of Statistical data: Measures of Central Tendency & Dispersion; Correlation and Regression; Expectation and Variance; Random variables; Discrete and Continuous distribution; Poisson, Normal and Binomial distribution; Chebysheff's inequality. Assignments on the aforesaid topics	
Unit II	**Vector Algebra: 4L+2T** Basics of vector algebra; Dot and Cross products of two vectors; Product of three or more vectors; volume of tetrahedron; Work done; Moment; Angular velocity. Applications to mechanics; Assignments on the aforesaid topics.	
Unit III	**Vector Calculus: 6L+3T** Vector functions of a scalar variable; Limit; Continuity and Derivative of vector functions; Applications to mechanics; Partial derivatives of vector function of more than one variables; Directional derivative; Gradient; Divergence and Curl; Vector Integration; Line integrals; Surface integrals and volume integrals; Green's theorem in the plane; Gauss Theorem; Stokes' Theorem and their application; Tangent Normal and Binormal of space curve; Serret-Frenet formulae; Normal plane, Rectifying plane and oscillating plane Assignments on the aforesaid topics.	
Unit IV	**Ordinary Differential Equations: 6L+3T** First order differential equations - exact, linear and Bernoulli's form, second order differential equations with constant coefficients, method of variation of parameters, general linear differential equations with constant coefficients, Euler s equations, system of differential equations. Assignments on the aforesaid topics.	
Unit V	**Partial Differential Equations: 8L+4T** First order PDE; Lagrange method; Second order PDE with constant coefficients and their classification to Elliptic, Parabolic and Hyperbolic type. Solution of PDE by method of separation of variables; Solution of one-dimensional wave and diffusion equation; Laplace equation of two dimensions. Assignments on the aforesaid topics.	

Text Books	1. Kreyszig, E."Advanced Engineering Mathematics" 8thEdition, John Wiley and Sons, (Asia) Pvt., Ltd, Singapore, 2000. 2. Grewal, B.S.,"Higher Engineering Mathematics" (35thEdition), Khanna Publishers, Delhi, 2000.
Reference Books	1. Dennis G.Zill and Warren S.Wright. "Advanced Engineering Mathematics". 3rdEdn. Jones & Bartlett Publishers, UK. 1992.
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination
Course delivery format	Class room lecture, Tutorial and Discussion
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

FET/BS/B/Math/T/211 : Mathematics-III		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
	CO 1	**3**	**2**	**1**	**1**											
	CO 2	**3**	**2**													
	CO 3	**3**	**2**	**1**	**1**											
	CO 4	**3**	**2**	**1**	**1**											
	CO 5	**3**	**2**	**1**	**1**											
	CO 6	**3**	**2**	**1**	**1**											

Course code: IEE/PC/B/T/212	Circuit Theory	L T P C 3 1 0 4
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122, BS/PH/TP104**	
Objectives:	The course aims to provide adequate knowledge about ● The fundamental laws and elements of electrical circuits. ● The energy properties of electrical elements and the techniques to measure voltage and current. ● Transient and steady-state responses of circuits. ● Application of circuit analysis to DC and AC circuits. ● Advanced mathematical methods such as Laplace transforms along with linear algebra and differential equations techniques for solving circuits problems. ● Three phase ac circuits	
Course Outcomes:	On completion of the course, the students will be able to CO1: Define and explain basic concepts of circuits(K1, A1) CO2: Describe the transient behaviour of circuits(K2,A1) CO3: Describe the sinusoidal behaviour of circuits (K2,A1) CO4: Discuss the applications of circuit theorems in different circuits, including 3-phase circuits (K3-apply,A2)	
Unit I	**Introduction : 8hrs CO1** Systems Concepts: Causality, linearity and time-invariance, Principle of superposition, Circuit as a system, Integro-differential equation representation. Passive Elements and Sources: Mathematical representation of ideal resistors, inductors and capacitors, Real or non-ideal passive elements, Ideal independent voltage and current sources, Dependent sources.	
Unit II	**Circuit theorems : 10hrs CO1** Ohm's law revisited, ohmic and non-ohmic elements, Kirchoff's current and voltage laws, Series and parallel circuits, Maxwell's mesh current method, Node voltage method, Thevenin's theorem, Norton's theorem, Source transformation and its application, Maximum power transfer theorem, Simple circuits using dependent sources. Assignment on application of these theorems.	
Unit III	**Transients in Circuits: 8hrs CO2** Simple R-L and R-C series circuits, Solution of simple R-L, R-C and R-L-C circuits containing dc excitation. Application of Laplace Transforms in circuit theory. Concept of s-domain variables. Assignment on RLC circuits and application of Laplace Transforms.	
Unit IV	**Sinusoidal Steady-state Analysis: 8hrs CO3** Sinusoid and its transformation to a phasor, Current and voltage phasors in single-element circuits, Concept of reactance, impedance, susceptance and admittance as phasors. Assignment on use of sinusoidal analysis techniques.	
Unit V	**Circuit analysis using circuit theorems : 8hrs CO4** Parallel and series-parallel circuits, Apparent, real and reactive power, Power factor, Maxwell's mesh current method and Thevenin's theorem in AC circuits, Series resonance, Bandwidth and Q-factor, Parallel resonance, Mutual inductance and coupled circuits. Assignment on application of these theorems.	
Unit VI	**3-Phase Circuits: 6hrs CO4** Generation of a balanced, 3-phase supply and its phasor representation, Phase and line voltages and currents for star- and delta-connected loads, Power and reactive power measurement using two-wattmeter method. Assignment on phasors, power and star-delta connected load circuit analysis..	
Text Books	1) Engineering Circuit Analysis by W. H. Hayt& J. E. Kemmerly, McGraw-Hill Book Company Inc.	
Reference Books	1) Fundamental of electric circuits by C. K. Alexander and M. N. O. Sadiku, Tata McGraw-Hill Education, 2nd edition, 2002.	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Power point teaching and assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	

Other learning activities	Group discussions, problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/ B/T/212: Circuit Theory	**CO 1**	**3**	**1**	**1**												
	CO 2	**3**	**2**	**1**												
	CO 3	**3**	**2**	**1**												
	CO 4	**2**	**3**	**1**												

Course code: IEE/PC/B/T/213	**Fundamentals of Instrumentation**	**L T P C** **3 0 0 3**
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122, BS/PH/TP104, BS/CH/TP103**	
Objectives:	The course aims to provide adequate knowledge about ● a general instrument, its components, mode of operation, the input-output configurations and the various types of signal conditioning used for these instruments. ● static and dynamic characteristics of various systems and their time and frequency responses to different inputs. ● errors in measurement and their statistical analysis. ● various types of sensing elements.	
Course Outcomes:	On completion of the course, the students will be able to CO1: Describe an instrument including their functional elements, input output configurations and signal conditioners used. (K1, A1) CO2: State, explain and illustrate the various performance characteristics of a general instrument. (K1, K2, A1) CO3: Compute the errors in measurement from experimental data and perform their statistical analysis. (K3,A2 - show) CO4: Describe the commonly used electrical, thermal and radiation type sensing elements including their principles of operation, specifications and circuits.(K1, A1)	
Unit I	**Introduction : 10hrs :CO1** Basic concept of Instrumentation system: functional elements of an instrument, electrical equivalents of mechanical and other systems, input-output configurations. classification of systems according to their mode of operation Signals: Types of signals and their characteristics, Signal conditioning. Signal modulations, deflection bridges, a.c carrier systems Continuous time Fourier series, Continuous time Fourier transform	
Unit II	**Performance characteristics: 8hrs : CO2** Systems: Types of systems and their behavior. Mathematical modeling of the system: System realizations using Laplace transform. Convolution and Differential equations, Definition & determination of Transfer function of a system. Performance characteristics: static characteristics, loading effects, Dynamic characteristics of a system: frequency response analysis, and response of a general form of instrument. Assignment on determining performance characteristics for practical systems.	
Unit III	**Errors in Measurement and Statistical analysis: 10hrs :CO3** Errors in measurement: definitions, noise in measurement systems using statistical concept Statistical concept: probability distribution function, chi-square test, curve fitting technique, power spectral density and autocorrelation. Static characteristics of a system: relating with statistical analysis. Assignment on application of error measurement in system design and performance analysis.	
Unit IV	**Sensing Elements: 28hrs :CO4** Basic sensing elements: Resistive elements (potentiometer, strain gage), (resistance thermometers) Capacitive elements (variable separation, area, dielectric), Inductive elements (variable inductance, (inductive) potentiometer, variable reluctance, LVDT), Magnetic type (eddy current, magnetostrictive, magnetoresistive), Hall devices, Piezoelectric element, (Piezo resistive element), Squid. Thermal transducers: RTD, thermistors, (hot wire anemometers) Radiation detectors (bolometers, pyroelectric type), (optical pyrometer) Photo detector, Case studies on application of these sensors in industrial scenarios.	
Text Books	1) Transducers and Instrumentation, D. V. S. Murthy, Prentice-Hall Inc. (2nded.), 2010. 2) Introduction to Measurements and Instrumentation, A. K. Ghosh, Prentice-Hall Inc. (4thed.), 2012.	

Reference Books	1) Measurement Systems: Application and Design, E. O. Doebelin, McGraw Hill (4th ed.), 1990. 2) Principle of Measurement Systems, J. P. Bentley, Pearson Education (4th ed.), 2005. 3) Instrumentation for Engineering Measurements, James W. Dally, William F. Riley, Kenneth G. McConnell, John Wiley & Sons(2nd ed.), 2006. 4) The Measurement, Instrumentation and Sensors Handbook, John G. Webster, CRC Press, 1998.
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination
Course delivery format	Primarily black board teaching and tutorial assignments
Supplementary academic support	Providing links to online instrument manufacturer and maintenance sites, providing additional learning materials from research papers
Other learning activities	Group discussions of recent developments in sensing technology based on research papers, demonstration of various industrial type instruments, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/ B/T/213: FUND OF INSTRU	**CO 1**	**3**	**1**													
	CO 2	**3**	**1**												**1**	
	CO 3	**2**	**3**	**1**											**1**	
	CO 4	**2**	**3**												**1**	

Course code: IEE/PC/B/T/214	**Electronic Circuits**	**L T P C** **3 1 0 4**

Course Prerequisites	**ES/BE/T102B**
Objectives:	The course aims to provide adequate knowledge about ● The construction and working principle of different types of diode circuits ● Philosophy and performance of various electronic amplifier circuits ● Architecture and behavior of different feedback topologies in amplifier circuits ● Structure and characteristics of RC and LC oscillator circuits ● Role of power amplifiers in electronic circuits
Course Outcomes:	On completion of the course, the students will be able to CO1: Classify and analyze different types of diode circuits (K2,K4, A1-explain) CO2: Identify and interpret the importance of biasing in electronic amplifiers (K3, A1-recognize) CO3: Describe and explain the behavior of small signal amplifiers (K2, A1) CO4: Differentiate and examine feedback circuits of various kinds (K4, A2) CO5: Explain and analyze the operation of oscillators (K2-describe, K4, A1)
Unit I	**Introduction: 8 Hrs: CO1** Introduction to diode circuits: Rectifier, Clipper, Clamper, Filter- Circuit diagrams with performance indices Assignment on diode circuits
Unit II	**Introduction to Electronic Amplifiers: 8 Hrs: CO2** Classification of amplifiers, Basic transistor amplifier circuits, Different modes of operation: CE, CB, CC, Different types of biasing techniques and bias stability. Assignment on different biasing techniques
Unit III	**Small Signal Behavior of Amplifiers: 8 Hrs: CO3** Small signal models of BJT amplifiers: π-model, hybrid model, Concept of DC and AC load lines, Calculation of voltage and current gains, Principles of multistage amplification, different topologies for multistage amplifier: CE-CE, CE-CB, CE-CC, Circuit diagrams and associated small signal models Assignment on BJT small signal amplifiers
Unit IV	**Frequency Response Characteristics of Small Signal Amplifiers: 6Hrs: CO3** Role of various capacitors on the overall frequency response of single stage amplifier-coupling capacitor, bypass capacitor, load capacitor, transistor stray capacitor, Miller effect and its implication, frequency response of multistage amplifiers Assignment on frequency response of BJT amplifiers
Unit V	**Feedback Amplifiers: 10 Hrs: CO4** Basic concept of feedback, Effect of feedback on several parameters pertaining to amplifier circuits, Different topologies of feedback: Current-series, Voltage-shunt, Voltage-series, Current-shunt, Calculation of closed loop gain for each of the feedback amplifier circuits
Unit VI	**Oscillators:6 Hrs: CO5** Fundamental idea behind oscillation, Barkhausen criterion, RC oscillators: Phase shift and Wien bridge oscillator, LC oscillators:Hartley and Colpitt oscillator
Unit VII	**Differential amplifiers:4 Hrs: CO3** Introduction to differential amplifier, Necessity and advantages, Notion of common mode and differential mode, Realization of differential amplifier using BJT
Text Books	1) Donald A Neamen, "Electronic Circuits: Analysis and Design", McGraw Hill. 2) J. Millman and C. C. Halkias, "Electronic Devices and Circuits", McGraw Hill. 3) Thomas L Floyd, "Electronic Devices: Electron Flow Version", Prentice Hall of India.
Reference Books	1) A. Mottershead, "Electronic Devices and Circuits: An Introduction", Prentice Hall of India. 2) A. Malvino and David J Bates, "Electronic Principles", McGraw Hill.
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination
Course delivery format	Primarily black board teaching, ICT based teaching and tutorial assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	

Recommended by the Board of Studies on	
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CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/B/ T/214: Electronic Circuits	CO 1	2	1	1	3	1									2	
	CO 2	3	2	1		2									1	
	CO 3	3	1	1	1	2									1	
	CO 4	3	2	2											1	
	CO 5	3	1	1		2	1								1	

Course code: IEE/PC/B/T/215	**Digital Electronics**	**L T P C** **3 0 0 3**
Course Prerequisites		

Objectives:	The course aims to provide adequate knowledge about ● positional number systems, radix conversions and several coding techniques. ● techniques of combinational logic design and logic minimization processes. ● programmable logic devices for integrated system designs. ● different logic families and their interfacing problems. ● sequential logic systems – both synchronous (Moore and Mealy machines) and asynchronous design techniques.
Course Outcomes:	On completion of the course, the students will be able to CO1: classify and describe various number systems and codes; (K1, K2, A1) CO2: explain operations related to binary arithmetic. (K2-describe, A1) CO3: sub-divide any given combinational system design problem into smaller modules and sub-modules, design and validate each of them, and finally combine them properly to accomplish the desired system performances. (K4, A2-validate) CO4: categorize different types of memory elements, integrate them to develop different sequential logic circuits. (K4, A2-model)
Unit I	**Positional Number Systems and Codes: 4 hrs. : CO1** Number systems and codes - Positional number system, Radix conversion; Different types of BCD, ASCII, EBCDIC; Gray code; Gray to Binary and Binary to Gray conversion techniques. Related Assignments and Problem Analysis.
Unit II	**Binary Arithmetic : 6 hrs : CO2** Binary Arithmetic - R's and (R-1)'s complement representation, Subtraction using 1's and 2's complement representation, Concept of overflow, BCD addition.
Unit III	**Combinational Logic Design : 18 hrs : CO3** Fundamental logic operators, Boolean Algebra. Combinational Logic Design – Definition, Truth Table, SOP and POS realization from truth table, Logic minimization using K-map, Minterms and Maxterms, Minimization with don't care terms, Quine-McClusky's tabular method of logic minimization, Concept of combinational hazard, Examples of combinational logic design : Adder / Subtractor circuits; 2's complement ripple carry adder/subtractor circuit, Parity generator/checker circuit, Circuit for Binary to Gray and Gray to Binary conversion. Encoder, Decoder, Demultiplexer and Multiplexer, Function realization using decoder and multiplexer. Case studies on Combinational Logic Designs. Programmable Logic Devices – PROM, PLA, PAL, FPGA. ROM and RAM. Integrated Circuit Logic Families - TTL, PMOS, NMOS, CMOS, ECL.
Unit IV	**Sequential Logic Design : 16 hrs : CO4** Sequential machine design - Concept of Moore and Mealy machine, State transition diagram and State transition table, Various memory elements, NAND-latch and its use, Clocked flip-flops, SR, JK, D, T. Timing constraints on edge triggered flip-flops; Changing one type of Flip-flop to another type, Design of sequence detector. Asynchronous and synchronous counter design. Different types of registers. Case Studies on Sequential Logic Design problems.
Text Books	1) Digital Logic and Computer Design, M. M. Mano, Prentice-Hall Inc.
Reference Books	1) Digital Electronics, G. K. Kharate, Oxford University Press. 2) Digital Logic Design Principles, N. Balabanian and B. Carlson, John Wiley & Sons. 3) Digital Electronics and Design with VHDL, V. A. Pedroni, Morgan Kaufmann Publishers
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination
Course delivery format	Primarily black board teaching, assignments and problem solving sessions.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials
Other learning activities	Group discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	
Recommended by the Board of Studies on	

Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/T/215: Digital Electronics		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
	CO 1	3	1													
	CO 2	3	2	1												
	CO 3	3	2	1	1											
	CO 4	3	2	1	1											

Course code: IEE/ES/B/T/216	**APPLIED FLUID MECHANICS**	**L T P C** **3 0 0 3**
Version No.		
Course Prerequisites	**BS/MTH/T111, BS/MTH/T112, BS/PH/TP104**	
Objectives:	The course aims to provide adequate knowledge about ● The concepts of fluid ● Analysis of fluid ● General concepts of laminar, turbulent and compressible flow ● Fluid machinery	
Course Outcome:	On completion of the course the students will be able to **CO1:** Classify fluids based on properties and its application when fluid at rest. (K2) **CO2:** Develop the governing equations for different flow conditions and solve flow related problems. (K3, A2-show) **CO3:** Develop equations for compressible flow and solve numerical problems including compressors(K3, A2-show) **CO4:** Apply laws of fluid mechanics for pumps, hydraulic turbines and flow measuring devices (K3)	
Unit I	**Introduction : 12hr** Fluid properties, Fluid statics, Equation of continuity, Euler equation, Motion of confined fluid, Bernoulli's equation, Principles of energy and momentum. Assignments on aforesaid topics.	
Unit II	**Fundamental concepts of flow: 14hrs** Principles of energy and momentum, Laminar and turbulent flow, Reynold's number, Viscous flow through pipes, Hydraulic gradient, Turbulent flow through open conduits, Compressible flow.	
Unit III	**Different flow: 12hrs** Relationship equations, Mach. No., Flow through nozzles, Shock wave through convergent and divergent nozzles.	
Unit IV	**Different fluid machinery: 10hrs** Fluid machinery - pumps, compressors, water turbines, fluid motors etc. Fluid flow measurements and instrumentation for open and closed conduits.Case studies on fluid flow measurements.	
Text Books	Applied Fluid Mechanics 7/E, 2014 , Robert L. Mott, Joseph A. Untener, Prentice Hall Applied Fluid Mechanics 3/E, 1990, Robert L. Mott, Merrill Publishing Company.	
Reference Books	Applied Fluid Mechanics for Engineers by SchobeiriMeinhard , The McGraw-Hill Company	
Mode of Evaluation	Written CAT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping: (3 – Strong, 2 – Moderate and 1 – Weak)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2													
CO2	3	2	1												
CO3	3	2													
CO4	1	2	3	1											

Course code: IEE/PC/B/S/211	Digital Circuits Laboratory	L T P C 0 0 3 1.5
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: apply and explain the concepts of minimized combinational logic design. (K3, A1) CO2: organize any given combinational system design problem into smaller modules and sub-modules, implement and validate each of them (K3, S2) CO3: implement different types of memory elements and examine their characteristics (A2, S2) CO4: integrate the memory elements to develop different sequential logic circuits and examine their performances. (K3, A2, S2-implement)	
Syllabus :	Case studies on Design and verification (Hardware and/or Simulation) of: 1. A simple combinational logic, like De-Morgan's law, basic gates using universal logic gates. 2. Half adder, full adder circuits 3. Half subtractor, full subtractor circuits. 4. 4:1 multiplexer, 1:4 demultiplexer 5. 4-bit binary to gray and gray to binary code converters 6. 2-bit comparator 7. Clocked SR latch, JK latch. 8. Asynchronous up/down counter 9. Synchronous up/down counter	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/S/211: Digital Circuits Laboratory		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
	CO 1	3	1											2		
	CO 2	3	2	1										2		
	CO 3	3	2	1	1									2		
	CO 4	3	2	1	1									2		

Course code: IEE/PC/B/S/212	**Electronic and Instrument Workshop**	**L T P C** **0 0 3 1.5**
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Examine different electronic components and surface mount devices(K1,A2) CO2: Build elementary PCB using electronic design and simulation package; and fabricate and test the same. (S2, A2-model,examine) CO3: Case Study and operate electronic test and measuring equipment (Multimeter, Oscilloscope, Function generator, Desktop Regulated Power Supply) and indicators, recorders, annunciation system and Instrument panels(A2,S2) CO4: Fabricate regulated power supply using full-wave bridge rectifier, capacitor filter and zener diode / IC regulator.(K3-construct, S2-build)	
Syllabus :	1. Case Study of different electronic components: Resistance, capacitance, inductor, diode, LED display devices, transistor, electromagnetic relay, Integrated Circuits. 2. Case Study on Elementary printed circuit board design, fabrication and testing.(CO2) 3. Introduction to an electronic design and simulation package.(CO2) 4. Introduction to surface-mount devices. 5. Soldering / Desoldering practice.(CO2) 6. Case Study of electronic test and measuring equipment: Multimeter, Oscilloscope, Function generator Desktop Regulated Power Supply. 7. Case Study of full-wave bridge rectifier with capacitor filter, zener diode and IC regulator. 8. Acquaintance with Instrument panels, indicators, recorders, annunciation systems.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PC/B/S/ 212: Electronic and Instrument Workshop	CO 1	3	1											1		
	CO 2	2	1	3										1		
	CO 3	2	3	1										1		
	CO 4	2	2	3	2									1		

Course code: IEE/PS/B/S/213	**Seminar**	**L T P C** **0 0 3 1.5**
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Adapt themselves towards a given domain of engineering topics (A3) CO2: Compose technical report on given engineering topics (K5, S5) CO3: Defend their report before a technical forum (K6, A5) CO4: Practice interactive/group discussion on given engineering and associated topics (A4)	
Syllabus :	Each student will give a technical seminar presentation on a topic that relates to the course curricula, preferably on recent technological advances or current developments. This will be followed by a group discussion among the attending students.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/S/213: Seminar		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
	CO 1	**1**	**2**				**2**	**2**				**2**	**3**		**1**	**1**
	CO 2	**1**	**2**				**2**	**2**	**2**		**3**	**2**				
	CO 3		**2**			**1**	**2**	**2**			**3**	**2**			**1**	**1**
	CO 4		**2**				**2**	**2**		**3**		**2**				

Course code: IEE/PC/B/IT/T/221	Data Structure, Algorithms & OOPs	L T P C 3 0 0 3
Course Prerequisites	**ES/CM/TP104A**	
Objectives:	The course aims to provide adequate knowledge about ● The concepts of Big Oh notation and analysis of complexities of algorithms ● Realizing linear & nonlinear data structures and its usefulness. ● Implementation of stacks, queues and its applications ● Recognize binary trees and perform different types of operations on trees ● Learning all sorting and searching algorithms.	
Course Outcomes:	On completion of the course, the students will be able to CO1: Understand data structures their advantages, drawbacks its types and analyzealgorithms (K2, K4, A1) CO2: Explain, apply and analyze different types of linear and non-linear data structures(A1, K3, K4) CO3: Explain and illustrate different techniques of searching and sorting and differentiate them in terms of performance (A1, A3, K2, K3) CO4: Explain, illustrate and recognize the basic features of classes, objects andencapsulation mechanisms. (A1, A3, K2, K3) CO5: Illustrate the extended features of OOPs (Inheritance, Polymorphism, Operatoroverloading) and apply them to solve practical problems. (K3, A2-show)	
Unit I	**Introduction:** Concepts of data structures, Abstract Data Type and Data Types. Algorithms and programs, Basic idea of pseudo-code, Introduction to Big Oh notation, use of order notations and related results, time complexity and space complexity, worst-case and average-case analysis of algorithms	
Unit II	**Linear Data Structure I:** Different Array representation row major, column major Sparse matrix - its implementation Linked List: Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.,	
Unit III	**Linear Data Structure II:** Stack and its implementations (using array, using linked list), applications. Queue, circular queue, de-queue. Implementation of queue- both linear and circular (using array, using linked list), Assignments on real life problems using linked list (Blockchain), linear and circular array	
Unit IV	**Nonlinear Data structures:** Basic terminologies, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), non-recursive traversal algorithms, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). Case studies on real life problems using binary tree and binary search tree	
Unit V	**Sorting Algorithms:** Bubble sort and its optimizations, Insertion sort, Selection sort, Quicksort , heap sort (concept of max heap, application – priority queue), Merge Sort, Radix sort. Case studies on real life problems using different sorting algorithms	
Unit VI	**Searching:** Sequential search, Binary search, Interpolation search.Case studies on real life problems using different searching algorithms	
Unit VII	**Basic Programming Concepts:** Data Types, Operators, Control Statements & Loops, Functions & Parameters, Arrays, Pointers & References, Class & Object, Abstraction / Encapsulation, Access Specifier , Static Member, Friend Function ,Constructor and Destructor	

Unit VIII	**OOPs with C++:** Function and Operator Overloading , Inheritance and Derived Class , Abstract Class, Runtime Polymorphism, Virtual Base Class, Overriding, Assignments on programming problems
Text Books	1. Data Structures and Algorithms by Aho, Hopcroft& Ullman 2. Data Structures in C by Aaron M. Tenenbaum 3. Data Structures by S. Lipschutz 4. The C++ Programming Language by Stroustrup, Adisson Wesley 5. Object Oriented Programming in C++ by R. Lafore, SAMS
Reference Books	1. Data Structures in Java by Sahni 2. Algorithms + Data Structures = Programs by N. Wirth, PHI 3. How to solve it by Computers by Dromey, PHI
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination
Course delivery format	Blackboard teaching Use of LCD projector for Presentations Problem solving instructions in the lab Laboratory Manuals Tutorials
Supplementary academic support	Video course online NPTELhttp://nptel.iitm.ac.in/ MIT Open course http://ocw.mit.edu/index.htm EduSat-https://www.itschool.gov.in/edusat
Other learning activities	Class discussions, Group sessions on programming problems, Relate to other courses in the curriculum with examples,
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/IT/T/221: Data Structure, Algorithms & OOPs		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
	CO 1	3	1												1	
	CO 2	1	2	3											2	
	CO 3	1	2	3											2	
	CO 4	1	2	3											2	
	CO 5		3	2	2										2	

Course code: IEE/PC/B/T/222	**Analog Integrated Circuits**	**L T P C** **3 1 0 4**
Course Prerequisites	**IEE/PC/B/T/214**	
Objectives:	The course aims to provide adequate knowledge about ● basic analog integrated circuits and their developments. ● Operational Amplifier fundamentals. ● basic analog systems both linear and non-linear, based on Operational Amplifiers. ● active filters, oscillators and waveform generators. ● limitations of practical Operational Amplifiers. ● several usages of IC timer. ● interfacing between analog and digital domains.	
Course Outcomes:	On completion of the course, the students will be able to CO1: Describe the salient features of analog integrated circuits and the fundamentals of Operational Amplifier. (K1, A1) CO2: Construct and analyze various linear analog circuits, e.g. amplifiers, adder, instrumentation amplifiers, integrators, differentiators, etc. (K3, A2-examine) CO3: Construct and analyze various nonlinear analog circuits, e.g. comparators with positive feedback, multivibrators, oscillators, other waveform generators, active filters, precision rectifiers, etc. (K3, A2-examine) CO4: Describe the critical aspects of the limitations of practical Operational Amplifiers, study the timer circuits and DAC – ADC modules. (K1, A1)	
Unit I	**Operational Amplifier Fundamentals: CO1** Amplifier Fundamentals, Op-Amp Characteristics. Op-Amp in open loop comparator mode, Different applications. Basic Op-Amp Circuits, V-I Converter with floating and grounded load : Case Studies.	
Unit II	**Linear Op-Amp Circuits : CO2** Inverting and Non-inverting amplifiers, Adder, Current amplifier, Difference amplifier, Instrumentation amplifier. Analysis of some typical Op-Amp circuits. Ideal and Practical Integrators, Differentiators and solution of differential equations. Generalized Impedance Converter and RLC ladder simulation design. Case studies on Linear Op-Amp Circuit designs and related problems.	
Unit III	**Non-linear Op-Amp Circuits:CO3** Schmitt trigger and applications, Precision rectifiers, Peak detectors, S/H circuits. Active filters. Multivibrators :Astable, Monostable. Wien bridge oscillator, Triangular waveform generator, Saw-tooth waveform generator. Log/Antilog Amplifiers, Analog Multipliers and their applications. Case studies on Non-Linear Op-Amp Circuit designs and related assignments.	
Unit IV	**Practical Op-Amp limitations, Timer application and ADC-DAC: CO4** D.C errors, Slew rate, Frequency response, Noise effect. Integrated Circuit Timer 555 and its applications. Analogue to Digital Converters and Digital to Analog Converters. Related Case Studies.	
Text Books	1) Operational Amplifiers and Linear Integrated Circuits, R. F. Coughlin and F. F. Driscoll, Prentice-Hall of India Pvt. Ltd.	
Reference Books	1) Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Franco, WCB McGraw-Hill. 2) Operational Amplifiers and Linear ICs, D. A. Bell, Oxford University Press. 3) Operational Amplifiers and Linear Integrated Circuits, K. L. Kishore, Pearson Education	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Primarily black board teaching, assignments and problem solving sessions.	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials	
Other learning activities	Group discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course	**IEE/PC/B/S/221**	

Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/T/222: Analog Integrated Circuits		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
	CO 1	**3**	**1**													
	CO 2	**3**	**2**	**1**	**1**	**1**									**1**	
	CO 3	**3**	**2**	**1**	**1**	**1**									**1**	
	CO 4	**3**	**1**	**1**		**1**									**1**	

Course code: IEE/PC/B/T/223	**Industrial Instrumentation**	**L T P C** **3 1 0 4**
Course Prerequisites	**IEE/PC/B/T/213**	
Objectives:	The course aims to provide adequate knowledge about ● The operating principles of sensors and systems used for the measurement of physical variables namely - force, torque, position, displacement, velocity, acceleration, and pressure. ● Sensor signal conditioning and transmission techniques, selection criteria. ● Application aspects of sensors and measurement systems used in professional practice, specifically in industrial automation.	
Course Outcomes:	On completion of the course, the students will be able to CO1: Explain the analog electronic and pneumatic, signal transmission techniquesand devices used in process industries.(K2-describe,A1) CO2: Describe the operating principle of sensors used to measureposition, displacement, velocity and acceleration. (K2,A1) CO3: Describe the operating principles and outline the applicationaspects of pressure measurement systems.(K2, A1) CO4: Explain the operating principle of force and torque measurementsystems.(K2-describe, A1)	
Unit I	**Analog electronic transmitters & Pneumatic systems: CO1: 14hrs** Introduction to electronic transmitters. Sensor linearization techniques, redundant measurement systems. Flapper-nozzle assembly. Pneumatic relays, air filter regulator, pneumatic force balance systems, introduction to compressed air supply systems. Assignment on application of linearization techniques and force balance systems	
Unit II	**Measurement of position, displacement, velocity, acceleration: CO2 : 14 hrs** Limit switch, Proximity Sensors - Inductive, Photoelectric, Capacitive and Magnetic. Shaft encoders, Tachogenerators, Tachometers. stroboscopes. Accelerometers. Introduction to vibration measurement. Assignment on application of stroboscopes. Accelerometers and vibration measurement.s	
Unit III	**Measurement of pressure and vacuum**: **16hrs: CO3** Concept of absolute, gauge and differential pressure. Pressure units and measurement principles. Elastic pressure sensors: bourdon tube, bellows, diaphragm and capsule. Manometers. Pressure gauge. Pressure switch. Electronic pressure transmitters: capacitive, piezo-resistive and resonator type. Calibration of pressure measuring devices. Installation of pressure measuring devices in different services. Measurement accessories - chemical seal and snubbers. Vacuum measurement: Mcleod gauge, thermal conductivity and ionization gauge. Assignment on application of pressure measuring devices. Accelerometers and Vacuum measurement	
Unit IV	**Force and Torque measurement systems: 12hrs: CO4** Strain gauge, strain gauge signal processing, Load cells: column, shear and bending beam type. magnetostrictive load cell. Introduction to industrial weighing systems and belt conveyor weighing systems. Weigh feeders. Principle of torque measurement in rotating shafts. Case study on applications of the load Cells.	
Text Books	1) D.Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill. 2) E.O. Doebelin: Measurement Systems Application and Design, Tata McGraw Hill.	
Reference Books	1) Liptak B.G, Instrumentation Engineers Handbook (Measurement), Chilton Book Co., 2) John G Webster, Measurement, Instrumentation and Sensors, Handbook, CRC Press 3) Walt Boyes, Instrumentation Reference Book, Butterworth Heinemann.	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Presentations, black board teaching, educational video and and assignments	

Supplementary academic support	Providing links to webinars, white papers on the subject matter from leading Industrial houses.
Other learning activities	Group discussions, problem solving sessions Occasional plant visits and lectures by Industry experts.
Supporting Laboratory course	IEE/PC/B/S/312
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/B/T/223: Industrial Instrumentation	**CO 1**	**3**	**2**	**1**												
	CO 2	**2**	**3**	**1**		**2**									**1**	
	CO 3	**2**	**3**	**1**		**2**									**1**	
	CO 4	**2**	**3**	**1**		**2**									**1**	

Course code: IEE/PC/B/T/224	**Linear Control Systems**	**L T P C** **3 1 0 4**
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122, FET/BS/B/Math/T/211, IEE/PC/B/T/212**	
Objectives:	The course aims to provide adequate knowledge about ● feedback control loop, its characteristics and the control components in various practical instruments. ● time and frequency responses of various systems to different inputs, their control interpretationsand interrelations. ● system stability analysis, computation of stability margins and their relation to transient responses. ● single loop controller design using lead/lag compensation while accounting for performance criteria, costs and constraints.	
Course Outcome:	On completion of the course, the students should be able to CO1: Describe some common practical control systems including its components and develop mathematical models of given physical systems stating assumptions. (K3, A1) CO2: Describe and illustrate the time and frequency responses of various systems to different inputs. (K3, A1) CO3: Analyze the stability of control systems using their time-domain or frequency-domain responses. (K4, A3-adapt) CO4: Analyze experimental data and design and develop SISO controllers from technical specifications of control systems. (K5, A4)	
Unit I	**Introduction : 10hrs: CO1** Control systems, Physical elements of a control system, Abstract elements of a control system, The design process. Laplace transfer functions. Mathematical Model of Physical Systems: Introduction, Differential equation representation of physical systems, Transfer function concepts, Block diagram algebra, Signal flow graphs. Review function, domain, range, linearity. Assignment on application of block diagram algebra, signal flow graphs.	
Unit II	**Basics of Control Systems : 8hrs: CO1** State variable representation: State variable model. Concept on Controllability and Observability, State models of linear continuous-time systems, Illustrative examples. Feedback Characteristics: Introduction, Reduction of parameter variation by use of feedback, Control of system dynamics by use of feedback, Control of effects of disturbance signals by use of feedback, Regenerative feedback, Illustrative examples. Control System Components: Introduction, DC servomotors, DC tacho-generators, AC servomotors, AC tachogenerators, Stepper motors, Accelerometer, LVDT. Assignments on state variable representations, feedback characteristics in systems involving the control components.	
Unit III	**Time Response Analysis : 8hrs: CO2, CO4** Introduction, Standard test signals, Performance indices, Time response of first order system, Time response of second order systems, Design specifications of second order systems, Compensation schemes, Tacho output rate feedback, integral compensation, Design specifications of higher order systems. Assignment on application of time response analysis for system evaluation and design.	
Unit IV	**Stability Analysis in Time Domain : 8hrs: CO3, CO4** The concept of stability, Assessment of stability from pole positions, Necessary conditions for stability, Routh stability criterion, Relative stability analysis, Illustrative examples-effect of K. The root locus concept, Root locus construction rules, Root contours, Case studies. Assignment on application of stability analysis for system evaluation and design.	
Unit V	**Frequency Response Analysis : 8hrs: CO3, CO4** Introduction, parallels from time domain analysis, Performance indices, Frequency response of second order systems, Polar plots, Bode plots, All pass systems, Minimum-phase and Non-minimum-phase systems-significance, Case studies: Illustrative examples.	
Unit VI	**StabilityAnalysis in Frequency Domain : 8hrs:CO3, CO4** Introduction, A brief review of principle of argument, Nyquist stability criterion, Assessment of relative stability – Gain Margin and Phase Margin using Nyquist criterion, Closed loop frequency response, Illustrative examples. Assignment on application of frequency response analysis for system evaluation and design.	

Unit VII	**Introduction to Design : 6hrs: CO4** The design problem, Concepts of cascade and feedback compensation, Realization of basic compensators, Case studies. Assignments on composite approach for system evaluation and design.
Text Books	1) Automatic Control Systems, B. C. Kuo, Prentice-Hall Inc. (3rd.ed.) 1975. 2) Modern Control Engineering, D. Roy Choudhury, Prentice-Hall Inc., 2005.
Reference Books	1) Modern Control Engg, K. Ogata, Prentice-Hall Inc. (3rd.ed.), 1997. 2) Control Systems Engineering, Norman S. Nise, Wiley International (6th ed.), 2011. 3) Control Systems: Principles and Design, M. Gopal, Tata McGraw Hill 3rdEdn, 2008.
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination
Course delivery format	Primarily black board teaching and tutorial assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Group discussions, problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	**IEE/PC/B/S/311** .
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/B/ T/224: Linear Control Systems	**CO 1**	3	1													
	CO 2	2	3	1												
	CO 3	1	3	2	1										1	
	CO 4	2	2	3	1	1									1	

Course code: IEE/PC/B/T/225	**Signal Transmission & Communication Systems**	**L** 3	**T** 0	**P** 0	**C** 3
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122, FET/BS/B/Math/T/211, IEE/PC/B/T/212, IEE/PC/B/T/214, IEE/PC/B/T/215**				
Objectives:	The course aims to provide adequate knowledge about ● Concept of signals and different mathematical operations on it ● Amplitude and angle modulation and demodulation ● AM, FM Transmitter and receiver ● Concept of transmission line, characteristics ● Antenna fundamentals and wave propagation				
Course Outcome:	On completion of the course, the students will be able to CO1: Define, classify different types of signals and calculate Fourier series and Fourier transformation on signals. (K2, A1-recognize) CO2: Describe amplitude, angle modulation and demodulation techniques (K1, A1) CO3: Demonstrate the basic characteristics and comparisons of different AM and FM transmitter and receiver (K3, A2-show). CO4: Define, classify transmission lines, describe different types of antennas and wave propagation (K2, A1)				
Unit I	**Representation of signals: 4 hrs. : CO1** Representation of signals; Generalized periodic waveforms, trigonometric and exponential Fourier series, Fourier transform, Convolution, Correlation, Energy and power spectral densities. Case-studies on different signals and their spectrum obtained through the transformation techniques. Assignments on selected topics.				
Unit II	**Modulation techniques : 16 hrs : CO2** Amplitude modulation - representation, frequency spectrum, power relations; Generation of AM, linear and nonlinear modulation; Single sideband (SSB) techniques - generation, carrier suppression, suppression of unwanted sideband, extensions of SSB, pilot carrier systems, vestigial sideband transmission. Frequency modulation - Theory of FM and PM, Generation of FM, Pre-emphasis and de-emphasis, Circuit schemes and comparisons, VCO's - circuits and applications. Assignments on the selected topics				
Unit III	**Transmitters and receivers: 8 hrs : CO3** AM and FM transmitters - basic characteristics and comparisons, different transmitter types; Receivers - Super heterodyne types; AM receivers – Frequency changing and tracking, Mixers and converters, Detection and AGC, communication receivers; FM-receivers - common schemes, comparison with AM types, Amplitude limiting, different demodulator/detector circuits. Assignments on the selected topics				
Unit IV	**Transmission line: 16 hrs : CO4** Theory of transmission line - General solution, lumped and distributed parameters, the infinite line, propagation velocity, waveform distortion, distortion less line, reflections, insertion loss, equivalent sections, terminations, characteristic impedance, Smith Chart applications; load matching techniques, microwave waveguides, antenna fundamentals, Radiation Pattern, Dipole, Folded dipole, Yagi-Uda, Log-periodic, Spiral antennas. Surface wave propagation, Ionosheric propagation. Assignments on the selected topics.				
Text Books	1) Communication Systems by Simon and Haykin, Wiley.				
Reference Books	1)Communication Systems byB.P.Lathi, Oxford Publishers 2) Signals and Systems by B.P.Lathi, Oxford Publishers				
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination				
Course delivery format	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples				
Supplementary academic support					
Other learning activities					

Supporting Laboratory course	
Recommended by the BOS on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/T/ 225: Signal Transmission and Communication Systems		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
	CO 1	3	2			1									1	
	CO 2	3	2	2		1									1	
	CO 3	1	3	2	1										1	
	CO 4	1	3	2	1										1	

Course code: IEE/PC/B/T/226	Measurements and Electronic Instrumentation	L T P C 3 0 0 3
Course Prerequisites	**IEE/PC/B/T/212, IEE/PC/B/T/213, IEE/PC/B/T/214, IEE/PC/B/T/215**	
Objectives:	The course aims to provide adequate knowledge about ● Working principles of different types of electrical and electronic meters and their applications. ● Working principles of different types of electronic instruments like oscilloscopes,function generators, LCR meter. ● Data transmission standards and ports of the measuring instruments ● Basic concepts of virtual instrumentation.	
Course Outcome:	On completion of the course the students will be able to CO1: Describe electrical and electronic voltmeters and ammeters and measurement procedures of resistance, capacitance and inductance (K2,A1). CO2: Explain the functions of a potentiometer, wattmeter, energy meter, oscilloscope (K2-describe, A1) CO3: Explain the sources of interference signals and the methods of elimination (K2-describe, A1) CO4: Describe the commonly used data transmission standards and virtual instrumentation system (K2,A1)	
Unit I	**Introduction to electrical voltmeters and ammeters: CO1: 6hrs** PMMC, MI, Electrodynamometer: Construction, range extension, Assignments on numerical problems on voltmeters and ammeters	
Unit II	**Measurement of Resistance, Inductance and Capacitance: CO1: 6hrs** Measurement of Resistance: Wheatstone bridge & Kelvin's Double bridge (DC Bridge), Loss of charge method, Megger Measurement of Capacitance: De Sauty's bridge & Schering bridge (AC Bridge) Measurement of Inductance: Maxwell's inductance capacitance bridge (AC Bridge), Assignments on numerical problems on DC and AC bridges	
Unit III	**PLL, Potentiometer, Wattmeter, Energymeter: CO2: 4hrs** PLL : Block diagram, circuit diagram, PLL as a frequency synthesizer, Charge amplifier Basic concept of Potentiometer, Wattmeter and Energy meter, Case studies with PLL	
Unit IV	**Electronic voltmeter, ohmmeter, frequencymeter, Q-meter: CO1: 8hrs** Analog electronic voltmeter – AC and DC, True RMS voltmeter, Digital Voltmeter, Digital frequency meter, Q Meter, Assignments on numerical problems on electronic voltmeters and ammeters, frequency meter, Q meter	
Unit V	**Oscilloscope: CO2: 10 hours** Oscilloscope Time Base, Triggering, Oscilloscope Controls, Oscilloscope Probes, Digital Storage Oscilloscope	
Unit VI	**Interference Signals and Data transmission standards: CO3: 6 hours** Resistive, capacitive, inductive and ground loop interference and their elimination methods, Case studies on real life problems with interference signals Serial data transmission standards: RS232, RS422, RS 485 Parallel data transmission standards: IEEE 4888, Assignment on design of a data transmission system with instruments	
Unit VII	**Introduction to Virtual Instrumentation systems: CO4: 4 hours**	
Text Books	1. Golding E.W. &Widdis F.C. : Electrical Measuring Instruments & Measurements; Wheeler 2. Helfrick A.D. & Cooper W.D. : Modern Electronic Instrumentation & Measuring Instruments; Wheeler 3. Bell, David : Electronic Instrumentation & Measurement, Reston Publishers 4. D.C. Patranabis, Principles of Electronic Instrumentation, PHI	
Reference Books	1. Harris, F. K. – Electrical Measurements, Wiley. 2. Bernard Oliver and John Cage, Electronic measurements and Instrumentation, McGraw Hill	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Black board teaching and assignments	

Supplementary academic support	Providing links to online instrument manufacturer and maintenance sites, providing additional learning materials from research papers
Other learning activities	Problem solving sessions in groups
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/T/226: Measurements and Electronic Instrumentation		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	2	1	1		3									1	
	CO2	2	1	1		3									1	
	CO3	3	2			1									2	
	CO4		1			3									2	

Course code: IEE/PC/B/S/221	**Analog Electronics Laboratory**	L T P C 0 0 3 1.5
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Implement and analyze diode and transistor amplifier circuits. (S2,A3-analyze) CO2: Implement and analyze linear circuits with op-amp. (S2,A3-analyze) CO3: Implement and analyze oscillator and nonlinear circuits using op-amp. (S2, A3-analyze) CO4: Implement and explain 555 Timer based circuits. (S2, A1)	
Syllabus :	Case studies on : 1. Study of clipping and clamping circuits 2. Study of DC and AC analysis of BJT and FET amplifiers. 3. Study of parameters of practical op-amp 4. Use of op-amps- Non-inverting and Inverting amplifier, buffer, adder, subtractor 5. Differentiators, Integrators 6. Multivibrators using op-amps. 7. Astable&monostablemultivibrators using IC 555 8. Wien Bridge Oscillators. 9. Study of precision rectifiers. 10. Triangular Wave Generator.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/S /221: Analog Electronics Laboratory		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
	CO 1	3	1											3	1	
	CO 2	3	2	1	1									3	1	
	CO 3	3	2	1	1									3	1	
	CO 4	3	1	1										3	1	

Course code: IEE/PC/B/S/222	Computing Software Laboratory	L T P C 0 0 3 1.5
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Develop and execute programs in MATLAB (A4, S2) CO2: Replicate and examine various systems under SIMULINK environment (A2, S1) CO3: Design and simulate electronic circuits using PSPICE (A2-model, S2-execute) CO4: Design and develop programs using LABVIEW (A2-model, S4)	
Syllabus :	Case studies and assignments on code development on: 1. Introduction to MATLAB as simulation tool and generation of various periodic and non-periodic signals using MATLAB 2. Analysis of the impact of quantization on the speech signal and verification of existing properties of signal quantization using MATLAB 3. Verification of the properties of LSI system using MATLAB 4. Introduction to SIMULINK as a tool to simulate multi-stage systems 5. Design of diode based half-wave and full-wave rectifier circuits using PSPICE 6. Design and study the transient behavior of RC integrator and differentiator circuit using PSPICE 7. Design and simulation of gain-frequency response of single and multi-stage RC coupled amplifier circuits using PSPICE 8. Introduction to LABVIEW to develop programs using graphical programming syntax	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PC/B/S /222: Computing Software Laboratory	CO 1	1	1	2	1	3								2		
	CO 2	1	1	2	1	3								2		
	CO 3	1	1	2	1	3								2		
	CO 4	1	1	2	1	3								2		

Course code: IEE/PC/B/T/311	**Digital Signal Processing**	**L T P C** **3 0 0 3**
Course Prerequisites	**BS/MTH/T/111, BS/MTH/T/122, FET/BS/B/Math/T/211**	
Objectives:	The course aims to provide adequate knowledge about ● Concept of Discrete and Digital Signals and Systems, its comparison with analog counter part ● Different Transforms in discrete domain: Discrete Fourier Transform (DFT), Fast Fourier Transform, Z-Transform ● Design of Digital Filters: General, FIR, IIR ● Filter structure and its usage ● Effect of Finite word length	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe and interpret the mathematical models of discrete time signals and systems (K2, A1) CO2: Calculate and interpret Fourier transform and Z transform of signals and systems (K3, A1-explain) CO3: Design and examine digital filters (K5, A3-differentiate) CO4: Understand and recognize the importance of multi-rate digital signal processing (K2, A1)	
Unit I	**Introduction : 4hrs :CO1** Description of signals and systems: types of signals and their characteristics, types of systems and their behavior, discrete-time description of signals: discrete-time sequences, their frequency domain behavior, comparison with analog signals, sampling a continuous function to generate a sequence, reconstruction of continuous-time signals from discrete-time sequences, Illustrative examples and assignments.	
Unit II	**Description of discrete-time systems: 8hrs:CO1** Discrete-time description of systems: unit-sample response of a system, time-invariant systems, superposition principle for linear systems, stability criterion for discrete-time systems, causality criterion for discrete-time systems, linear constant-coefficient difference equations, convolution of two sequences, Illustrative examples and assignments.	
Unit III	**Fourier transform: 8hrs :CO2** Discrete time Fourier transform: definition of Fourier transform (FT), important properties of FT, properties of FT for real-valued sequences, use of FT in signal processing, FT of special sequences, the inverse FT, FT of the product two discrete-time sequences, program to evaluate the FT by computer. Discrete Fourier Transform: The definition of the Discrete Fourier Transform (DFT), computation of the DFT from the discrete-time sequence, properties of the DFT, circular convolution, performing a linear convolution with the DFT, computations for evaluating the DFT, programming the DFT, increasing the computational speed of the DFT, intuitive explanation for the decimation-in-time FFT algorithm, analytic derivation of the decimation-in-time FFT algorithm, some general observations about the FFT, Illustrative examples and assignments.	
Unit IV	**Z-transform: 6hrs: CO2** Z-transform: Definition of the z-transform, properties of the z-transform, the system function of a digital filter, combining filter sections to form more complex filters, digital filter implementation from the system function, the complex z-plane, the region of convergence in the z-plane, determining the filter coefficients from the singularity locations, geometric evaluation of the z-transform in the z-plane, relationship between the Fourier transform and the z-transform, the z-transform of symmetric sequences, the inverse z-transform, Illustrative examples and assignments.	
Unit V	**Digital Filters: 12hrs :CO3** Definition and anatomy of a digital filter, frequency domain description of signals and systems, typical applications of digital filters, replacing analog filters with digital filters, filter categories, types of digital filter: FIR and IIR, recursive and non-recursive, digital filter structures: direct form I and II structures, cascade combination of second-order sections, parallel combination of second-order sections, linear-phase FIR filter structures, frequency-sampling structure for the FIR filter, Effect of word length: round off error, truncation error, quantization error, limit cycle, Illustrative examples and assignments.	

Unit VI	**Multi-rate DSP:6hrs:CO4** Introduction to multi-rate DSP, sampling rate conversion, implementation of sampling rate conversion in FIR filters, poly-phase decomposition, applications of multi-rate DSP, Illustrative examples and assignments.
Text Books	1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill. 2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall of India. 3. C. T. Chen, "Digital Signal Processing", Oxford University Press.
Reference Books	1. Luis F. Chapprao, "Signals and systems using Matlab", Elsevier. 2. S.W. Smith, "The Scientist and Engineers guide to digital Signal Processing", California Technical Publishing San Diego, California. 3. A. NagoorKani, "Digital Signal Processing", McGraw Hill. 4. L. Tan and J. Jiang, "Digital Signal Processing: Fundamentals and Applications", Elsevier.
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination
Course delivery format	Black board teaching and assignments Slide Projected lecture, Problem Solving Assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	**IEE/PC/B/S/321**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/B/ T/311: **Digital Signal Processing**	CO 1	3	1												1	
	CO 2	1	2		1	3									2	
	CO 3	1	2	3	1										1	
	CO 4	1	2	2	3										1	

Course code: IEE/PC/B/T/312	**Microcontrollers**	**L** **T** **P** **C** 3 0 0 3
Course Prerequisites	**IEE/PC/B/T/215, IEE/PC/B/T/222**	
Objectives:	The course aims to provide adequate knowledge about ● Hardware and software features of a typical 8-bit microcontroller ● Supporting peripheral devices to design a stand-alone controller board ● Developing application software on a microcontroller platform using standard cross-compilers	
Course Outcome:	On completion of the course, the students will be able to CO1: Review the hardware architecture and memory organization of a typical 8-bit microcontroller (K2, A2-study) CO2: Develop and debug assembly language/C programs using standard cross-compilers. (A4, K3) CO3: Review the on-chip hardware modules, viz. Timers, Interrupts and UARTS of a processor (K2, A2-study) CO4: Illustrate the interfacing of peripheral devices, viz. ADC, DAC, RTC, Display Controller and Keyboard (K3, A2-study)	
Unit I	**Introduction to microcontrollers: 8hrs : CO1** Basic introduction. Microcontrollers vs. Microprocessors. Hardware architecture, memory organization and Timing and the machine cycle of Intel 8051 microcontroller.	
Unit II	**Introduction to microcontroller programming: 10 hrs : CO2** Overview of 8051 instruction set and introduction to assembly language programming. Introduction to Keil C cross-compiler. Assignments on code development.	
Unit III	**Understanding the microcontroller on-chip modules: 10 hrs : CO3** Understanding the functioning of the on-chip timers, interrupts, and serial port of the 8051 microcontroller. Developing codes for running the on-chip modules. Case studies on typical interrupt-driven timer and serial port applications.	
Unit IV	**Development of a stand-alone microcontroller board: 16hrs : CO4** Basic overview of selected off-the-shelf ADC, DAC, RTC and Display Controller. Paper design of an 8051 microcontroller board with ADC, DAC, RTC, display controller and keyboard. Case studies on ADC, DAC applications and time and date stamped data acquisition.	
Text Books	1) The 8051 Microcontroller, I. Scott Mackenzie, Raphael C.W. Phan, Pearson Education, India	
Reference Books	1) The 8051 Microcontroller, Architecture, Programming and Applications, Kenneth J. Ayala, West Publishing Company **2)** Programming and Customizing the 8051 Microcontroller, Myke Predko, Tata McGraw-Hill	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and tutorial assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping: (3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/T/312: Microcontrollers		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3	2	1												
	CO2	2	3		1	2										
	CO3	3	2		1									1	1	
	CO4	1	2	2	3	1								2	1	

Course code: IEE/PC/B/T/313	**Process Dynamics and Control**	**L T P C** **3 0 0 3**
Course Prerequisites	**IEE/PC/B/T/212, IEE/PC/B/T/223, IEE/PC/B/T/224**	
Objectives:	The course aims to provide adequate knowledge about ● Development of mathematical models to describe the dynamics of processes ● Design of process controllers and their tuning ● Dynamic behaviour of closed-loop control systems ● Final control elements	
Course Outcome:	On completion of the course, the students will be able to CO1: Develop mathematical models of typical processes (K3, A2-model) CO2: Explainand analyse the performance of different controllers and their tuning methods (K4,A2-examine) CO3: Differentiate between various control schemes and interpret their necessity (K4,A3) CO4: Explain the role of final control elements in process control systems (K2, A1)	
Unit I	**Introduction : 10hrs : CO1** The basic concepts of process control, different blocks in the loop. Process variables, Process modeling principles and techniques, Modeling considerations for control purposes, degree of freedom analysis. Development of process models, Model order reduction, linearization of nonlinear process models. Case study on modelling of typical process control unit	
Unit II	**Control actions: 10hrs: CO2, CO3** Modes of control actions – on-off, P, PI, PID, Different forms of PID controllers, Characteristics of process responseunder different types of controllers, Reset windup. Positional and velocity form of PID controllers. Auto/manual transfer. Assignments on numerical problems for different control actions.	
Unit III	**Schemes and analysis of process control strategies:20hrs: CO2, CO3** Behavior of a typical closed-loop process control systems. PID control – design and tuning, Feedforward control, Ratio control, Cascade control, Split-Range control, Selector control, Anti-reset control. Dead-time compensation – Smith predictor. Case studies on application of different control schemes over real processes	
Unit IV	**Final control elements:10hrs : CO4** Final control elements – actuators and control valves, valve positioners. Characteristics of control valves – inherent and installed characteristics. Sizing and selection criteria of control valves. Cavitation and flashing . Case studies on application of different types of valves in real system	
Text Books	1) Process Dynamics & Control by D. E. Seborg, T. F. Edgar & D. A. Mellichamp, 2nd eds., John Wiley & Sons.	
Reference Books	1. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia. 2. Automatic Process Control – D.P. Eckman, 7theds.,John Wiley, New York, 1990.	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Power point teaching and assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/B/ T/313: Process Dynamics and Control	CO 1	3	1	1											1	
	CO 2	2	3	1	1										1	
	CO 3	1	3	2	1	2									1	
	CO 4	2	3	1											1	

Course code: IEE/PC/B/T/314	**Process Instrumentation**	**L T P C** **3 0 0 3**
Course Prerequisites	**IEE/PC/B/T/213, IEE/PC/B/T/223**	
Objectives:	The course aims to provide adequate knowledge about • the operating principles and application aspects of temperature, level, flow sensors and measurement systems used in process automation • smart field devices used in process plants and the communication protocols used by such devices • hazardous locations and the techniques of explosion protection used therein	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe the operating principles and the application aspects of level measurement systems (K2,A1) CO2: Explain the operating principles and the signal conditioning techniques of temperature sensors (K2-describe,A1) CO3: Describe the operating principles and outline the application aspects of flow measurement systems (K2,A1) CO4: Identify and classify hazardous locations and explain techniques used for explosion protection in such areas(K2, A1)	
Unit I	**Level Measurement: 14 hrs: CO1** Review of various level measurement methods, application considerations. Level measurement devices: Gauge glass, float & displacer type level sensors, D/P type level sensors, capacitive level sensors, ultrasonic & microwave level sensors, servo level gauges, hydrostatic tank gauging systems, conductivity level sensors, radiation level sensors, vibrating level switches. Case studies that corroborate the use of different level measurement techniques in industrial applications.	
Unit II	**Temperature Measurement**: **10hrs : CO2** Temperature scales, ITS90. Different types of thermometers: Bimetal, filled system thermometers, thermocouple, RTD, thermistors, IC temperature sensors, radiation thermometers, temperature switches. Thermowell, temperature calibrators and simulators.	
Unit III	**Flow Measurement: 16hrs: CO3** Flow measurement: Fluid properties, turbulent & laminar flow, Reynolds number, velocity profile, flow conditioners. Volume & mass flowrate, influence of pressure & temperature on volume flowrate, flow computers, totalization. Flow measurement techniques: differential pressure flowmeter, variable area flowmeter, magnetic flowmeter, mass flowmeter, vortex shedding flowmeter, positive displacement flowmeter, turbine flowmeter, ultrasonic flowmeter, target flowmeter. Measurement of flow of bulk solids. Criteria for selection and of flowmeter and flowmeter calibration. Case studies that corroborate the use of different flow measurement techniques in industrial applications.	
Unit IV	**Hazardous locations and techniques used for explosion protection: 10 hrs: CO4** Instrumentation in Hazardous locations: Area, material and temperature classification. Explosion protection – explosion proof enclosures, intrinsic safety, pressurization. Combustible gas detectors. Enclosure classification. Standards and certification: case studies.	
Unit V	**Introduction to Smart Field Devices: 6hrs:: CO1, CO2, CO3** Smart transmitters - features & advantages, HART protocol. Overview of field device networks - Field bus.	
Text Books	1) Principles of Industrial Instrumentation, by D. Patranabis, Tata McGraw Hill	
Reference Books	1) Instrumentation Engineers Handbook (Measurement), Liptak B.G, Chilton Book Co. 2) Process/Industrial Instruments and Controls Handbook, Gregory McMillan and Douglas Considine, McGraw Hill Professional 3) Instrumentation Reference Book, B.E. Noltingk, Butterworth-Heinemann	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Presentations, case studies on sensor applications, black board teaching and educational videos.	
Supplementary academic support	Providing links to webinars, white papers on the subject matter from leading Industrial houses.	
Other learning activities	Occasional plant visits, group tasks on best practices in industrial measurements and lectures by Industry experts.	

Supporting Laboratory course	Sensor & Signal Conditioning Laboratory: IEE/PC/B/S/312 Mini Project (Automation Laboratory): IEE/PS/B/S/322
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/B/T/314: Process Instrumentation	**CO 1**	2	3	1	1	2									1	
	CO 2	2	3	1	1	2									1	
	CO 3	2	3	1	1	2									1	
	CO 4	1	1			3	1								2	

Course code: IEE/PE/B/T/315A	Power Plant Instrumentation	L T P C 3 0 0 3
Course Prerequisites	IEE/PC/H/T/313, IEE/PC/H/T/315	
Objectives:	The course aims to provide adequate knowledge about ● General concepts of different power plant setups, energy conversion process ● Different types of instrumentation control system in power plant ● Instrumentation for safety-interlocks, protective devices and monitoring of environmental pollution ● Power plant simulators	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe the working principles and usability of the different power plant setups and energy conversion process (K2, A1). CO2: Explain the working principle of different types of instrumentation control system in power plant (K2-describe, A1). CO3: Describe instrumentation for safety-interlocks, protective devices and monitoring of environmental pollution.(K2, A1) CO4: Describe full functionality of power plant schemes and familiarization with interfacing using DCS (K2,A1).	
Unit I	**Different parts of power plant system : 18hrs : CO1** General concepts of different power plant setups and energy conversion process. Thermal power plant instrumentation –controlling, monitoring and testing of boilers, turbines, condensers, generators, coal-handling units and auxiliary systems, quality monitoring of air water and exhaust gas. Some case studies.	
Unit II	**Different power plants : 8hrs : CO2** Salient features of instrumentation in nuclear, hydroelectric and non-conventional power plants.Case studies illustrating these aspects.	
Unit III	**Safety measures : 8hrs : CO3** Instrumentation for safety-interlocks, protective devices; emergency measures; alarms and alarm analysis, monitoring of environmental pollution. Some case studies.	
Unit IV	**Data handling systems : 8hrs : CO4** Data-handling systems-data acquisition, processing, accounting, logging and display-storage systems.Assignment on data handling systems.	
Unit V	**Basic concept of power plant simulators : 6hrs : CO4** Introduction to power plant simulators.Assignment on related topics.	
Text Books	1) The control of boilers, Sam G. Dukelow, 2nd edition, ISA, 1991. 2) Power plant Engineering: Steam And Nuclea, P. K. Nag, Tata McGraw-Hill Education, 1998.	
Reference Books	1) Application Concepts of process control, Paul W. Murrill, ISA, 1998. 2) Fundamentals of thermodynamics and heat engineering, V.G. Erokhin, M.G. Makhanko, P.I. Samoilenko, 1986.	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PE/B/T /315A: Power Plant Instrumentation		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
	CO 1	3														
	CO 2	3	1		1			1								
	CO 3	2						3								
	CO 4	2	1			3		2								

Course code: IEE/PE/B/T/315B	Analog MOS Circuit Design	L T P C 3 0 0 3
Course Prerequisites	**ES/BE/T/102B, IEE/PC/B/T/214**	
Objectives:	The course aims to provide adequate knowledge about ● Behavior and characteristics of MOSFET ● Operating principles of MOS amplifier circuits ● Construction and working principle of differential amplifier and current mirror circuit ● Frequency response of MOS amplifiers	
Course Outcome:	On completion of the course, the students should be able to CO1: Classify and analyze different types of MOS amplifiers (K4, A1-recognize) CO2: Explain and interpretthe importance of differential amplifiers (K3, A1) CO3: Describe and explain the behavior of current mirrors (K2, A1) CO4: Explain and analyze the frequency response of MOS amplifiers (K4, A1)	
Unit I	**Introduction: 6 Hrs:: CO1** Review of MOS device physics, general considerations, MOS I/V characteristics, second order effects. Some case studies	
Unit II	**Single Stage MOS Amplifiers:12Hrs:: CO1** Basic concepts, Common source stage with different types of load, Source follower, Common gate stage, cascode stage, Illustrative examples and assignments on MOS amplifiers	
Unit III	**Differential Amplifiers:10Hrs:: CO2** Basic differential pair, Common mode response, Differential pair with MOS loads, Illustrative examples and some case studies	
Unit IV	**Current Mirrors: 6Hrs:: CO3** Basic current mirrors, Cascode current mirrors, active current mirrors, Illustrative examples. Assignment problems on current mirror	
Unit V	**Frequency Response of MOS Amplifiers: 8 Hrs:: CO4** General considerations, High frequency models of common source, source follower and common gate amplifier, Frequency response of cascode stage, Illustrative examples.	
Text Books	1. BehzadRazavi, "Design of Analog CMOS Integrated Circuit", McGraw Hill.	
Reference Books	1. Y. P. Tsividis, "Operation and Modelling of MOS Transistor", McGraw Hill. 2. Phillip E. Allen and DouglasRHolberg, "CMOS Analog Circuit Design", Oxford University Press.	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Primarily black board teaching, ICT based teaching and tutorial assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO, CO-PSO Mapping: (3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
IEE/PE/B/T/315B: Analog MOS Circuit Design	CO 1	2	1	3	1	1									2	
	CO 2	2	1	3	1	1									2	
	CO 3	3	1	1	1	2									1	
	CO 4	3	2	1											2	

Course code: IEE/PE/B/T/316A	VLSI Design	L T P C 3 0 0 3
Course Prerequisites	**IEE/PC/B/T/215, IEE/PC/B/T/222**	
Objectives:	The course aims to provide adequate knowledge about ● various technologies of VLSI ● fundamentals of chip fabrication and layout design rules ● small device geometries ● digital CMOS designs ● fault models relevant to testing and testability	
Course Outcome:	On completion of the course, the students will be able to CO1: Define various technologies for VLSI.(A1-describe, K1) CO2: Describe fundamentals of MOS fabrication &layout design rules.(A1,K2) CO3:Describe the physical limitations imposed by small device geometries and various second order effects in MOS.(A1,K2) CO4: Classify fault types and develop their modelling. (A4,K3)	
Unit I	**Introduction to VLSI: 4 hrs. : CO1** Categorization of Integrated Circuits; SSI, MSI, LSI, VLSI etc., Technologies for VLSI and their features: NMOS, CMOS, Bi-CMOS, GaAsMOSFET. Case studies on various technologies.	
Unit II	**Fabrication of MOSFETs: 6hrs : CO2** Diffusion, doping, oxidation, Epitaxial layer formation, photo, ion-beam and X-ray lithographies.Silicon, Aluminium, Copper and polysilicon etching. Local oxidation and dielectric isolation, ionimplantation. Outlines of Bipolar, MOS, CMOS and GaAs VLSI fabrication. Assignments on different steps and techniques of MOSFET fabrication.	
Unit III	**CMOS circuit design: 24hrs : CO3** Basic structure of p-well CMOS Inverter, circuit operation, voltage transfer characteristics, calculation of critical points and their physical significance, noise margins, design ofsymmetric inverter, power dissipation issues, inverter capacitances, transmission gates and perfectsignal steering, capacitance loads driven by transmission gates, NAND and NOR logic gates, stickdiagrams, comparison of performances, derivation of combinational networks from canonic forms, AND-OR INVERT gate, complex gates, Sutton's method of network synthesis, combinational networks usingShannon's expansion theorem, MOS inverters driven by pass transistors two-input and two-variable universal logic modules, sequential MOS logic circuits, pre-charge andevaluation phases, pseudo-NMOS, Domino and NORA circuits, λ- based design rules. ROM, Multiplexer, PLA, PAL, CPLD and FPGA based implementation of VLSI, Verilog Programming. Case studies of various design aspects.	
Unit IV	**Fault models: 8hrs : CO4** Testing and testability, Different fault models; stuck-at, short circuit and open circuit faults. Automatic test pattern generator (ATPG). Group discussions on various fault models.	
Text Books	1) K.Eshraghian. D.A. Pucknell and S. Eshraghian, "Essential of VLSI Circuits and Systems", Prentice Hall of India Pvt. Ltd.	
Reference Books	1) D.A.Pucknell and K.Eshraghian, "Basic VLSI Design", Prentice-Hall of India Pvt. Ltd 2) J.P.Uyemura, "Chip design for Submicron VLSI: CMOS layout and Simulation",Thomson India Edition 3)W.Wolf, "Modern VLSI design System- On chip Design", Pearson Education 4) Sherwani NA. Algorithms for VLSI physical design automation. Springer Science & Business Media; 2012	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and tutorial assignments.	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		

Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
IEE/PE/B/T/316A:VLSI Design	CO1	3	1												1	
	CO2	3	2												1	
	CO3	1	2	3											1	
	CO4	1	2	3											1	

Course code: **IEE/PE/B/T/316B**	**Analytical Instrumentation**	**L T P C** **3 0 0 3**
Course Prerequisites	**BS/CH/TP103, BS/PH/TP104**	
Objectives:	The course aims to provide adequate knowledge about ● Separation of chemical compositions ● Electrochemical methods of analysis ● Spectroscopic methods ● Analytical instruments	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe the basic principles of separation of chemical compositions using chromatographic techniques and mass spectroscopy (K2, A1) CO2: Explain the spectroscopic techniques of analysis (K2-describe, A1) CO3: Explain the electrochemical principles of analysis (K2-describe, A1) CO4: Describefew special techniques likeConductivity, Turbidity, Humidity, Viscosity measurements etc. and NMR(K2, A1).	
Unit I	**Gas Analysis: 10 hrs: CO1, CO3, CO4** Thermal Conductivity Type, Heat of Reaction Method, for oxygen analyzers – Paramagnetic, Dumbbell, Servomax, Thermomagnetic, Zirconia Cell type. Case studies with industrial applications of gas analyzers	
Unit II	**IR Spectroscopic Techniques: 12 hrs : CO2** IR Radiation Absorption Type, Dual-Channel IR Spectrometry, Single-Channel IR Spectrometry, IR Sources, Comparison of their performances, IR Detectors, Dispersive Spectrometry using Grating/Prism monochromator, FT-IR Spectrometer based on Michelson Interferometer. Case studies with industrial and other applications of IR spectrometers	
Unit III	**Spectroscopic Techniques in UV Visible and X-ray ranges: 12 hrs : CO2** Absorption in Visible and UV-range, monochromators and detectors, Sources and their ⎿ -ranges, Colorimetry, Atomic Spectral Methods: Emission and Absorption: Visible, UV and X-rays; sources, principles, detectors, sample preparation etc., XRD. Case studies with industrial and other applications of UV-Vis spectrometers, X-ray spectroscopy, XRD	
Unit IV	**Liquid Analysis: 12 hrs : CO3, CO4** Different Electrodes: Ion-selective and Molecular- selective types, their variations and application prospects, Dissolved Oxygen Analysis Cells, pH electrodes, circuits and applications, Conductivity Cells, Standards, Effect of frequency variation, circuits, Cells for different applications, Polarography: Determination of concentrations of constituents. Apparatus, Circuits; Pulse polarography, Case studies with industrial and other applications of electrochemical analysis	
Unit V	**Special Topics: 10 hrs : CO1, CO4** Chromatography, GC, GLC, LC, HPLC, Columns, Detectors; Different type of Microscopes- TEM, SEM, AFM Humidity and Moisture; Turbidity meter and Nephelometer; Viscosity and Consistency; Density and Specific Gravity; Introduction to NMR and ESR, Case studies with industrial applications	
Text Books	1) Principles of Instrumental Analysis- Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Thomson Brooks/Cole, 2007	
Reference Books	1) Liptak BG. Instrument Engineers' Handbook, Volume One: Process Measurement and Analysis. CRC press; 2003 2) Patranabis,D., Principles of Industrial Instrumentation, 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Primarily black board teaching.	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	

Other learning activities	Class discussions, Relate to other courses in the curriculum with examples, Tech talk by industry experts and interactions with the experts
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PE/B/T /316B: Analytical Instrumentation	**CO 1**	**3**	**1**	**1**											**1**	
	CO 2	**3**	**2**	**1**											**2**	
	CO 3	**3**	**2**	**1**											**2**	
	CO 4	**3**	**1**	**1**											**2**	

Course code: IEE/PC/B/S/311	**Control Systems Laboratory**	**L T P C** **0 0 3 1.5**
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Conduct an experiment to review a position control system using an inner velocity feedback loop and outer position feedback loop (K2, A2-examine, S2) CO2:Identify a 2^{nd} order model of an active filter circuit from its step response and find out the system parameters from its time response analysis. (K3, A3-recognize, S2-perform) CO3: Conduct an experiment to review the operation of a stepper-motor in open loop and its driver circuit (K2, A2-examine, S2) CO4: Based on MATLAB simulations, investigate the following: (i) Proportional and derivative control effect (ii) Effect offorward-path Lead Compensation on the performance of a position control servo-system. (K4, A2-examine, S3-demonstrate) CO5: Demonstrate the steady-state and transient performance of a nonlinear feedback control system, employing P and PI-type control, by using its small-signal linear model. (K3, S3)	
Syllabus :	Assignments on: 1. Study of a DC Position Control System 2. Identification of the 2nd-order Model of a Linear System from Step Response Test 3. Study of a Stepper Motor and its Translator 4. Study of Step Response of a Linear 2^{nd} order System using MATLAB 5.Simulation Study on Effects of Compensation Networks. 6. Study of a Illumination Control System	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
IEE/PC/B/S/ 311: Control Systems Laboratory	**CO 1**	3	2	1										1		
	CO 2	3	1	1										1		
	CO 3	3	2	1										1	1	
	CO 4	3	1	1		2								1		
	CO 5	2	3	1	2	2								2	2	

Course code: IEE/PC/B/S/312	Sensor & Signal Conditioning Laboratory	L T P C 0 0 3 1.5
Course Prerequisites	**IEE/PC/B/T/223**	
Course Outcomes:	On completion of the course, the students will be able to CO1: Calibrate and explain the features an analog two wire transmitter(A1,S3) CO2: Interpret the data-sheets, calibrate and evaluate the performance of position, displacement, velocity, acceleration & force sensors(A2-examine,S3) CO3: Calibrate and evaluate the performance of pressure and Temperature Sensors/transmitters(A2-examine,S3) CO4: Configure/parameterize HART compliant Smart transmitters (A5-Characterize, S5-Construct)	
Syllabus :	Assignments on: 1. Testing, evaluation and calibration of a 2-wire V to I converter. 2. Study, calibration and signal conditioning of an LVDT. Study of inductive, capacitive, optical and magnetic proximity sensors. 3. Measurement of RPM using incremental shaft encoder, proximity sensor and stroboscope. Vibration monitoring using proximity sensor and accelerometer 4. Calibration of a pressure gauge, pressure switch and a DP transmitter using a pneumatic calibrator / dead weight tester. 5. Calibration of temperature sensors and transmitter and study differential pressure flow elements. 6. Study and calibration of a load cell and testing of the associated electronics used to construct a weighing system. 7. Configuration and parameterization of a HART compliant, smart differential pressure / temperature transmitter 8. Study of pH/Conductivity measurement systems	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/S/ 312: Sensor & Signal Conditioning Laboratory		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
	CO 1	2				1								3	2	
	CO 2	2				1								3	2	
	CO 3	2				1								3	2	
	CO 4	2				1								3	2	

Course code: IEE/PS/B/S/313	**Mini Project (Electronic Design Lab)**	**L T P C** **0 0 3 1.5**
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Differentiate between behavioral and structural designs in VHDL. (K2, S1-organize) CO2: Organize VHDL Test-bench modules for simulating a circuit (K2-construct, S1) CO3: Implement and verify combinational logic circuits using behavioral and/or structural descriptions (K3-apply, S2) CO4: Implement and verify sequential logic circuits using behavioral and/or structural descriptions. (K3-apply, S2)	
Syllabus :	Mini Projects on digital circuits of different complexities (eg. Priority encoder, arbitrary sequence counter, sequence detector, sequence generator, multiplier, ALU etc.) using VHDL for design description. Projects to be designed and then verified by simulation using standard EDA tools. Real-time testing of the designs to be performed using FPGA/CPLD.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PS/B/S /313: Electronic Design Lab	**CO 1**	1	1			3								2		
	CO 2	1	1	1		3								2		
	CO 3	1	2	2	2	3								2	1	
	CO 4	1	2	2	2	3								2	1	

Course code: IEE/HS/B/Prod/T/321	INDUSTRIAL MANAGEMENT	L T P C 3 0 0 3
Course Prerequisites		
Objectives:	The course aims to provide adequate knowledge about ● Industrial management processes ● Solution of management problems using operational research techniques ● Concepts of maintenance and quality control ● Inventory and materials management techniques ● Concepts of organizational control	
Course Outcome:	On completion of the course, the students will be able to CO1: Classify industrial management processes. (K2, A1-describe) CO2: Solve management problems using various techniques of operational research. (K3, A2-model) CO3: Explain various concepts of maintenance and quality control. (K2, A1) CO4: Analyse inventory and materials management techniques. (K4, A2-examine) CO5: Illustrate concepts of organizational control. (K2, A2-show)	
Unit I	**Introduction to Industrial Management: 10 L** Epistemology of industrial management, its importance and relevance in the context of present industrial scenario. Types of industries and manufacturing systems - a few case studies. Principles and functions of management. Operations economy (break-even analysis). Production forecasting.	
Unit II	**Operational Research and Resource Management: 12 L** Introduction to operational research, linear programming (graphical and Simplex methods), duality. Transportation and assignment problems. Queuing theory. Game theory. Decision making and its models, fuzzy logic. Project network diagramming, CPM, PERT, time cost trade off, project crashing, line balancing. Case studies on industrial application of operation research	
Unit III	**Maintenance Management and Quality Control: 10 L** Maintenance management, reliability, replacement theory. Introduction to quality control, statistical quality control, Case studies with industrial and other applications of IR spectrometers	
Unit IV	**Materials Management: 6L** Inventory decision, EOQ, EPQ models, ABC analysis, VED, HML, SDE, FSN, XYZ analyses. MRP, JIT	
Unit V	**Organizational Control: 6L** Work environment. Theory of motivation. Organization and methods. Work study. Productivity, DEA, CCR model	
Text Books		
Reference Books		
Mode of Evaluation	Sessional – Written CT-I & II Final-Written Term End Examination	
Course delivery format	Black board teaching and assignments Slide Projected lecture, Problem Solving Assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		

Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/HS/B/Prod/T/321	**CO 1**		2				1		2	2	1	3				**1**
	CO 2			3		2	1			2						**1**
	CO 3		3				2		2			1				
	CO 4			3		2	1			2						**1**
	CO 5		3				2		2			1				

Course code: IEE/PC/B/IT/T/322	**Computer Organization, Architecture & Networking**	**L T P C** **3 0 0 3**
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122, ES/CM/TP104A, IEE/PC/B/IT/T/221**	
Objectives:	The course aims to provide adequate knowledge about ● the design and architecture of memory and processor ● the various functionalities of operating systems, pipelining and vector processing ● the different network topologies and fundamentals of computer networks ● the data link layer protocols and media access protocols ● different routing protocols and network protocols	
Course Outcome:	On completion of the course, the students will be able to CO1: Discuss and illustrate the design and architecture of memory and processor (K3, A2) CO2: Discuss and describe the various functionalities of operating systems, pipelining and vector processing (K2, A2) CO3: Describe the different network topologies and fundamentals of computer networks (K2, A1) CO4: Demonstrate and examinethe data link layer and network protocols (K3, A2)	
Unit I	**Processor Design:CO1: 4hrs** Processor Organisation, Instruction Set, Design of ALU.	
Unit II	**Control Design: CO1: 4hrs** Hardware and Microprogrammed Control Units	
Unit III	**Memory Design: CO1: 4hrs** Interleaved memory, Cache, Associative Memories, Virtual Memory, Paging and Address Translation	
Unit IV	**Operating Systems: CO2: 6hrs** Evolution, Memory and Processor Management, File System, Access and Allocation methods, Protection Case studies with operating systems like Linux and/or Windows	
Unit V	**Parallel Processing: CO2: 6hrs** Introduction, Principles of Pipelining and Vector Processing, SIMD and MIMD Models of Computation	
Unit VI	**Computer Networks: CO3, CO4: 18hrs** Introduction, ISO's OSI reference model, Switching Methods, CCITT (ITU) standards, Data Link Protocols, Routing and Flow Control, Access methods and Protocols, LAN, Bus and Ring Networks, IEEE Standards, TCP/IP Standards **Network layer and Internetworking :** IPv4: Packet format ; Classful addressing / subnetting / subnet mask; CIDR /supernetting / masks, IPv6: address format / packet format / differences with IP (v4C) Protocols: IP, ICMP, ARP Routing algorithm: concept of static and dynamic routing, Distance vector / Link state algorithm.	
Text Books	1)Tannenbaum: Computer Networks 2)Tannenbaum: Computer organization	
Reference Books	1)Forouzan 2) 3) 4)	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and tutorial assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		

Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PC/B/IT/ T/322: Computer Organization, Architecture & Networking	**CO 1**		**2**	**3**	**1**										**1**	
	CO 2	**2**	**3**	**1**	**1**											
	CO 3	**3**	**2**												**1**	
	CO 4	**2**	**3**	**1**	**1**										**2**	

Course code: IEE/PE/B/T/323A	Biomedical Instrumentation	L T P C 3 0 0 3
Course Prerequisites	**BS/CH/TP103, BS/PH/TP104, IEE/PC/B/T/212, IEE/PC/B/T/214, IEE/PC/B/T/215, IEE/PC/B/T/222, IEE/PC/H/T/313**	
Objectives:	The course aims to provide adequate knowledge about ● Measurement of physiological parameters ● Transducers for biomedical applications ● Principles of operation and details of the instruments like blood pressure measurement, ECG, Pacemaker, clinical laboratory equipments, Xrayimaging and CAT ● Biotelemetry and Electrical Safety	
Course Outcome:	On completion of the course, the students will be able to CO1: Classify and describe physiological parameters (K2, A1) CO2: Explain applications of transducers for biomedical uses (K3-apply, A1) CO3: Describe and illustrate the operations of blood pressure measuring devices, ECG machine, Pacemaker, clinical laboratory equipments, X-ray imaging machine, CAT and detail instrumentation of the medical instruments. (K3, A1) CO4: Classify and describe biotelemetry and electrical safety (K2, A1)	
Unit I	**General introduction in measurement of physiological parameters: 8 hrs. : CO1** General introduction including problems in measurement of physiological parameters. Sources of bioelectric potential, introduction of biopotential electrodes, its necessity and also its problems. Case studies illustrating these aspects.	
Unit II	**Transducers for biomedical applications: 12 hrs : CO2** Introduction to transducers for: Blood pressure measurement, electrocardiograph, blood count, flame photometry and image acquisition of CAT. Case studies of such applications.	
Unit III	**Principle of operation of biomedical instruments: 18 hrs : CO3** **Blood pressure measuring instruments**: invasive and noninvasive type, manual, semiautomatic and automatic type and details of sphygmomanometer. **Heart:** engineering analog of heart, model of heart, electrocardiograph - principle of the instrument, detail instrumentation, noises and interference in the measurement, its solutions, other systems of diagnosing the heart. **Pacemaker:** introduction, types, its detail instrumentation. **Instrumentation for clinical laboratory:** blood count, flame photometry. **X-ray imaging:** range for medical use, principle of x-ray generation, instrumentation of x-ray image. **Computer aided tomography (CAT):** basic principle, image acquisition, mathematical modeling for reconstruction of image, block representation of the instrument and detailing of some parts. Case studies of exiting instruments.	
Unit IV	**An introduction of Biotelemetry and Electrical Safety: 6 hrs : CO4** **Biotelemetry :-** an introduction **Electrical Safety:** - range of electrical power considered as safe, precaution to be taken for patient safety.	
Text Books	1)Cromwell L, Weibell FJ, Pfeiffer EA, Usselman LB. Biomedical instrumentation and measurements(Book- Biomedical instrumentation and measurements.). Englewood Cliffs, N. J., Prentice-Hall, Inc., 1973. 457 p. 1973.	
Reference Books	1)Khandpur RS. Handbook of biomedical instrumentation. McGraw-Hill Education; 1987.	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and tutorial assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials	
Other learning activities	Group discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		

Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PE/B/T/ 323A: Biomedical Instrumentation	**CO 1**	**2**	**3**	**1**												
	CO 2	**3**	**2**	**1**	**1**											
	CO 3	**1**	**1**	**3**	**2**	**1**	**1**								**1**	
	CO 4	**3**	**2**	**1**					**1**						**1**	

Course code: IEE/PE/B/T/324A	**DIGITAL IMAGE PROCESSING**	**L** 3 **T** 0 **P** 0 **C** 3
Course Prerequisites	**IEE/PC/B/T/311**	
Objectives:	The course aims to provide adequate knowledge about ● Extension of one dimensional signal processing into two dimensional signal processing for image analysis ● Digital image acquisition and basic operations for enhancement of image quality ● Spatial and frequency domain filtering of digital image ● Color image acquisition and processing	
Course Outcome:	On completion of the course, the students will be able to CO1: Classify and examine different types of image processing operations in spatial domain (K2, A2) CO2: Describe and explain the implication of image frequency in processing digital images (K2, A1) CO3: Describe the popular image processing algorithms and their applications (K2, A1) CO4: Study the fundamentals of color image processing (K2-understand, A2)	
Unit I	**Introduction : 4hrs :CO1** Overview of digital image processing, type of digital images and their representations, nature and type of image processing, digital image processing operations, application and relevance of digital image processing	
Unit II	**Digital Imaging System: 4hrs:CO1** Image acquisition, physical and biological aspects of image acquisition, sampling and quantization, image quality, image storage and file formats	
Unit III	**Image processing in spatial domain: 8hrs :CO1** Importance of point processing, basic point processing operations, histogram, thresholding, smoothing and sharpening spatial filters. Case studies using popular images	
Unit IV	**Image processing in frequency domain: 6hrs: CO2** Frequency components in digital images, two-dimensional discrete Fourier transform, concept of image filters, smoothing and sharpening frequency domain filters. Case studies using popular images	
Unit V	**Image restoration: 4hrs :CO3** Type of noise models, cleaning salt-pepper and Gaussian noise from the digital images, estimating the degradation functions, inverse filtering	
Unit VI	**Morphological operations:4hrs:CO3** Basic idea behind image morphology, dilation and erosion, opening and closing, the hit-or-miss transform, some basic morphological algorithms. Case studies using typical images	
Unit VII	**Image segmentation:4hrs:CO3** Detection of discontinuities, edge linking and boundary detection, region based segmentation. Application of image segmentation	
Unit VIII	**Image compression:6hrs:CO3** Importance of image coding and compression, image compression models, loss-less and lossy compression. Some case studies	
Unit IX	**Color image processing:4hrs:CO4** Basics of color image processing, color models, pseudo coloring	
Text Books	1) R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson Education , 2006 2) S. Sridhar, Digital Image Processing, Oxford University Press , 2012	

Reference Books	3) A.K. Jain, Fundamentals of Digital Image Processing, Pearson Education , 2007 4) L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Pearson Education , 2004
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination
Course delivery format	Power point based teaching and assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PE/B/T/324A Digital Image Processing	**CO 1**	**3**	**2**	**1**	**1**										**1**	
	CO 2	**3**	**2**	**1**	**1**										**1**	
	CO 3	**3**	**2**	**1**	**1**										**1**	
	CO 4	**3**	**2**	**1**	**1**										**1**	

Course code: IEE/PC/B/S/321	Digital Signal Processing Laboratory	L T P C 0 0 3 1.5
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Examine and execute MATLAB signal processing functions (S2, A2) CO2: Examine and execute different mathematical operations on discrete signals. (S2, A2) CO3: Examine and execute different digital filters (S2, A2) CO4: Demonstrate real time signals and examine their response with different digital filters (K3,S3-Demonstrate, A2)	
Syllabus :	Case studies and assignments on code development on: 1. MATLAB Review, Sequences, Operations with sequences, Linear Convolution, Synthesis of Sinusoidal Signals, The Sound Command, Multiplication of Sinusoids: Beat Notes, Amplitude Modulation. 2. Introduction to the DFT, The DFT of a rectangular window, The effect of zero padding a sequence on its spectral profile, Spectrum replication, The DFT of a signal that is the sum of sinusoids, The DFT of an AM waveform, The frequency axis in terms of the index k, w[rad/samp] and f [Hertzs], Aliasing, A simple low pass filter: the Moving Average 3. Filter, A simple high pass filter: the Moving Difference Filter, Design of echo filters, 4. Audio experiments.Frequency Resolution, Rectangular and Hamming Windows, Leakage, Bias, DTMFtones. White Noise. Peak Filters. Detection of Sinusoidal Signals Buried in Noise. FilterDesign by Pole-Zero Placement. 5. FIR and IIR Filter Design using MATLAB.Familiarization with DSP starter kits: Implementation of an IIR/FIR filter(LPF/BPF/HPF/ BSF) using a DSK/EVM (C50/C54/C62X).	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/S/ 321: Digital Signal Processing Laboratory		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
	CO 1	3	1	1		1								2	1	
	CO 2	3	1			1								2	1	
	CO 3	2	3	1		1								2	2	
	CO 4	2	3	1	1	1								2	2	

Course code: IEE/PC/B/S/322	**Process Control Laboratory**	**L T P C** **0 0 3 1.5**
Course Prerequisites		
Course Outcomes:	On completion of the course, the students will be able to CO1: Calibrate and examine different process variables with 4 to 20 mA standard signal.(A2, S3) CO2: Implement and explain different control schemes for different process variables. (A1, S2) CO3: Differentiate and apply tuning methods for different process variables(K3, A3 S2-implement) CO4: Apply different control algorithms and simulate model processes. (K3, A2, S2-perform)	
Syllabus :	1. Assignment for the study of the tuning of ON-OFF/ P/ PI/ PID controllers using a Process Control Simulator. 2. Case study for the operation of a level/flow control rig in the ON-OFF/ P/ PI modes using a PC based controller. 3. Case study for the operationof a temperature control rig in the ON-OFF/ P/ PI modes using a PC based controller. 4. Case study for the operation of a pressure control rig in the ON-OFF/ P/ PI modes using a PC based controller. 5. Assignment for the study the operation of a control valve in a panel mounted level/flow control rig using hardware or software based controllers. 6. Assignment for the study of various process control systems and simulation of various control algorithms using a process control simulation software.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/B/S /322: Process Control Laboratory		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
	CO 1	**1**	**1**			**3**								**2**		
	CO 2	**2**	**2**	**1**		**2**								**1**	**3**	
	CO 3	**2**	**2**	**1**	**1**	**2**								**1**	**3**	
	CO 4	**1**	**2**	**1**	**1**	**3**								**1**	**2**	

Course code: IEE/PS/B/S/323	**Mini Project (Microcontroller Laboratory)**	**L T P C** **0 0 3 1.5**
Course Prerequisites	**IEE/PC/H/T/314**	
Course Outcomes:	On completion of the course, the students will be able to CO1: Develop assembly language programs and C programs in KEIL C cross-compiler (µVision) for a standard AT89C51 microcontroller board (A4,S4) CO2: Apply the µVision debugger and the user interface in testing applications (K3,A2-examine,S2-implement) CO3: Develop a software to interface ADC and DAC ICs for analog I/O (K3, A4, S4) CO4: Develop a software to interface Keyboard and LCD Display Controller IC for data I/O (K3,A4,S4) CO5: Develop a software to interface RTC (Real Time Clock) IC for time keeping (K3,A4,S4) CO6: Develop a software to connect to a PC for data I/O through a serial link (K3,A4,S4) CO7: Design and implement Data Acquisition System and Digital Controllers using any standard microcontroller evaluation board (K5,A4-develop,S5)	
Syllabus :	1. Familiarization with a) AT89C51 microcontroller board, b) KEIL C cross-compiler (µVision). Group assignments to check hardware modules by writing relevant codes and downloading them on the target board. 2. Familiarization with the µVision debug modes and the user interface for testing applications; case studies on code debugging. 3. Group assignments on writing simple assembly language and C program codes to test the on-chip timers, interrupt inputs and UART. 4. Group assignments on interfacing the on-board ADC and DAC ICs for analog I/O 5. Group assignments on interfacingInterface the on-board Keyboard and LCD Display Controller IC for data I/O 6. Group assignment on interfacing of the on-board RTC (Real Time Clock) IC for time keeping 7. Group assignments on building a small DAQ system for a) Reading sensor signals, b) Sensor signal conditioning, c) Data transfer to a PC for storage. 8. Group assignments on building a standalone digital PID controller for speed control of a DC brushed motor	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PS/B/S/323: Mini Project (Microcontroller Laboratory)		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
	CO 1	**2**	**3**	**1**										**1**		
	CO 2	**1**	**2**	**3**		**1**								**1**		
	CO 3	**1**	**2**	**3**		**1**								**1**		
	CO 4	**1**	**2**	**3**		**1**								**1**		
	CO 5	**1**	**2**	**3**		**1**								**1**		
	CO 6	**1**	**2**	**2**	**3**	**2**								**2**	**2**	
	CO 7	**1**	**2**	**2**	**3**	**2**								**2**	**2**	

Course code: IEE/PS/B/S/324	Mini Project (Automation Laboratory)	L T P C 0 0 6 3
Course Prerequisites	**IEE/PC/H/T/313, IEE/PC/H/T/315**	
Course Outcomes:	On completion of the course, the students will be able to CO1: Draw and interpret simple P &ID Diagrams(A1-Explain, S2-build) CO2: Configure, parameterize and evaluate the performance of a VFD.(A5-characterize,S5-Construct) CO3: Evaluate an automated pneumatic actuating system, its components and calibrate smart field devices such as flow, level transmitters and actuators with smart positioners.(A2-examine,S3) CO4: Configure, program & test simple programs on a ProgrammableLogic Controller and develop PC based human machine interfaceusing a SCADA package.(A2-examine,S5-construct)	
Syllabus :	1. Familiarization with symbols and terminologies of P & I diagrams and drawing a P & I diagram using a CAD package.1. Case studies and assignments involving simple P & IDs. **Group assignments on:** 2. Configuration, parameterization and commissioning of an induction motor speed control system using a VFD. 3. Study of pneumatic and electro-pneumatic components. Assembly and evaluation of a simple automated pneumatic actuating system 4. Study and calibration of flow elements, indicators and transmitters 5. Study and calibration of level sensors and transmitters. 6. Study and characterization of a control valve with a pneumatic actuator and smart positioner. 7. Configuration, basic programming, testing and interfacing of a programmable logic controller (Siemens S7-1200 using TIA portal). 8. Study of software timers and counters of a PLC. 9. Programming and testing of a PC based Human Machine Interface developed using a SCADA package (WIN CC) and interfacing it with a PLC (Siemens S7-1200) for real time monitoring. 10. Study of a PLC based, close loop level / temperature control system. 11. Study of a PLC based motion / servo control system. 12. Introduction to basic PLC networking.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PS/B/S /324: Mini Project (Automation Laboratory)	CO 1	2				1								3		
	CO 2	2		1		1								3	2	
	CO 3	2		1		1								3	2	
	CO 4	2		1		1								3	2	

Course code: IEE/PS/B/S/325	**Mini Project (FPGA Lab)**	**L T P C** **0 0 3 1.5**
Course Prerequisites	**IEE/PC/B/T/215, IEE/PC/B/S/211, IEE/PS/B/S/313**	
Course Outcomes:	On completion of the course, the students will be able to CO1: Study and describe the primary features of the Xilinx families of FPGA(K2, A2) CO2: Create Verilog Test-bench modules for simulating a design (A3-adapt, S3-demonstrate). CO3: Implement combinational logic using behavioral and/or structural descriptions (S2, K3, A4-develop) CO4: Implement sequential logic using behavioral and/or structural descriptions. (S2, K3, A4-develop)	
Syllabus :	List of experiments to be tested and verified using Xilinx FPGA. Group Assignments on: 1. Design of 8-Bit Shift Register with shift Right, shift Left, Load and Synchronous reset. 2. Design a decimal up/down counter that counts up from 00 to 99 or down from 99 to 00. 3. Memory based FSM implementation using Verilog. 4. Design Arithmetic Logical Unit. Group Project on: 5. Implementation of random number generators. 6. Implementation of different edge detection algorithms	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PS/B/S/ 325: Mini Project (FPGA Lab)	CO 1	3	1											2		
	CO 2	2	1	3										2		
	CO 3	2	2	1	3									2	1	
	CO 4	2	2	1	3									2	1	

Course code: IEE/PC/H/ T/411	**TELEMETRY AND REMOTE CONTROL**	**L T P C** **3 1 0 4**
Course Prerequisites	**IEE/PC/B/T/225**	
Objectives:	The course aims to provide adequate knowledge about ● Concept of signals and different mathematical operations on it. ● Concept of data transmission, line and error control coding. ● Concept of wireless wave propagation ● Different types of modulation and multiplexing techniques ● Concept of satellite and fiber optics telemetry	
Course Outcome:	On completion of the course, the students will be able to CO1: Examine and identify telemetering signals and their transforms. (A2, K4) CO2: Examine, identify and apply data transmission, line and error control coding techniques. (A2, K4) CO3: Discuss and interpret basic characteristics of modulation, multiplexing, FDM and TDM Systems, Modems, wireless wave propagation techniques. (K3, A2). CO4: Describe and classify satellite and fiber optics telemetry (K2, A1)	
Unit I	**Basic Concept: Telemetering Signals and their Transforms: 8 hrs. : CO1** Basic Concept: Telemetry- its purpose and application potential, basic schemes-pneumatic, current, voltage, frequency over short distances. Line length limitations; Wired and wireless types. Signals and Transforms: Signals and their representation and transformation; Frequency spectra of pulses and pulse waveforms; continuous and discrete transforms; Noise- its distribution; Probability function. Case-studies on different signals and their spectrum obtained through the transformation techniques. Assignments on selected topics.	
Unit II	**Codes and Coding: 8 hrs: CO2** Concepts of information transfer, bits and symbols; coding source, line and channel; biasing. BCD, ASCII, EBCDIC, BAUDOT; AMI, CMI, Manchester (phase), HDBn, Block; Differential, LRC, Hamming, Convolution, M-ary; modulation Codes: PAM, PFM, PTM (PPM,PWM), PCM. Bit error rate, Parity checking, Effect of time delays and noise in bit information; Raised Cosine Spectrum and response; Noise induced bit errors etc. Case-studies on different error checking techniques. Assignments on selected topics.	
Unit III	**FDM and TDM Systems, Modems, wireless wave propagation techniques: 20 hrs: CO3** FM, PM, FM-FM, FM-AM, PAM-AM, PAM-FM, PCM-AM, PCM Sample and hold circuits, Quantization and Conversion methods, Errors in quantization; Bandwidth consideration. FDM and TDM Systems: Frequency division multiplexing and demultiplexing Systems, IRIG Standards in FDM telemetry; SCO's and their circuits- Multiplexing and Demultiplexing circuits; Detectors and Demodulators, Pulse Averaging, Quadrature FM and PLL; Mixers. TDM Systems, their circuits, scanning techniques; TDM-PAM, PAM-PM Systems, Synchronization, TDM-PCM System; PCM Generation, Differential PCM Systems, PCM reception and demodulation Modems: Digital modulation and shift keying techniques, ASK, OOK, FSK, PSK, DPSK, QPSK, etc, QAM; Modem Protocols, Synchronous protocols. Wave Propagation: Aspects of wave propagation; Space, Case-studies of probability of errors for different digital modulation schemes, Assignments on selected topics.	
Unit IV	**Satellite, Optical Telemetry: 8 hrs : CO4** Satellite Telemetry: Basics, TT&C Services and subsystems, the Subsystems, The earth station. Fiber Optic Telemetry: Optic fiber as a transmission medium; Interconnections; Repeaters; Source and Detectors; Receivers, wavelength division multiplexing. Assignments on selected topics.	
Text Books	1) Telemetry principles, D. Patranabis, Tata Macgraw-Hill, 2007. 2) Signal and systems, Simon Haykin, Barry Van Veen, 2 nd edition, John Wiley & Sons, 2007 3) Digital Communication, Simon Haylin, 3rd edition, John Wiley & Sons, 2008 4) Microwave devices and circuits, Samuel Y. Liao, Prentice-Hall, 3rd edition, 2002.	

Reference Books	1)Linear systems and signals, B.P.Lathi, Oxford University press, 2nd edition, 2005. 2) Modern Digital Analog Communication systems B.P.Lathi, Oxford University press, 2nd edition, 2005. 3) Electronic Communication Systems, Kennedy, Davis, 4th edition, Tata Macgraw-Hill, 2008.
Mode of Evaluation	Sessional – Written CT-I & II Final-Written Term End Examination
Course delivery format	Primarily black board teaching and tutorial assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	**IEE/PC/H/S/412**
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
IEE/PC/ H/ T/411 TELEMETRY AND REMOTE CONTROL	**CO 1**	3	2	1		2									1	
	CO 2	2	3	2	1	1									1	
	CO 3	2	3	2	1	2									1	
	CO 4	1	3	2	1										1	

Course code: IEE/PC/H/T/412	**Power Electronics**	**L T P C** **3 1 0 4**
Course Prerequisites	**ES/BE/T102B, IEE/PC/B/T/214**	
Objectives:	The course aims to provide adequate knowledge about ● Basic principles of power electronic devices like diodes, transistors and thyristors. ● Single phase and polyphase converter and inverter circuits. ● Speed control techniques of AC and DC motors. ● Switched mode power supplies and uninterruptible power supplies.	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe the working principles and usability of the different power electronic devices like diodes, transistors and thyristors. (K2, A1). CO2: Explain the working principle of single phase and polyphase converter and inverter circuits. (K2-describe, A1). CO3: Describe the speed control techniques of AC and DC motors..(K2, A1) CO4: Explain the working principle of switched mode power supplies and uninterruptible power supplies. (K2-describe, A1).	
Unit I	**Different power electronic devices like diodes, transistors and thyristors: 16 hrs: CO1** Power Semiconductor Devices: Rectifier diodes, fast recovery diode and Schottky barrier diode. Power BJT and power Darlington transistors, Power MOSFET. The thyristor family: SCR, triac, inverter-grade SCR, asymmetric SCR, reverse-conducting thyristor (RCT) and gate turn-off thyristor (GTO). SCR turn-on and turn-off methods. Insulated gate bipolar transistor (IGBT). Common triggering devices and their applications: UJT, diac and PUT.	
Unit II	**Single phase and polyphase converter and inverter circuits : 20 hrs : CO2** Phase-controlled Rectification and Inversion: Single-phase converter circuits. Polyphase converters: delayed commutation and commutation overlap, phase-controlled inverter, reactive power and power factor, free-wheeling operation, three-phase full-wave bridge converter, half-controlled bridge converter, regenerative converters. Assignments on selected inverter and converter topologies.	
Unit III	**Speed control techniques of AC and DC motors : 8hrs : CO3** Introduction to AC motor speed control and introduction of DC motor speed control.	
Unit IV	**Switched mode power supplies and uninterruptible power supplies : 4hrs : CO4** Introduction to switched mode power supplies and uninterruptible power supplies.Case study of selected topologies of SMPS and UPS.	
Text Books	1) Power Electronics, Circuits, Devices and Applications. M.H.Rashid,Pearson,2007	
Reference Books	1) Power Electronics, Singh and Khanchandani, McGraw Hill Education (India) Private Limited, 2013. 2) Sen PC. Power electronics. Tata McGraw-Hill Education; 1987	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications.	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/H/T/412: Power Electronics	CO 1	3														
	CO 2	3	2												1	
	CO 3	1	3			2									2	
	CO 4	2	3												2	

Course code: IEE/PC/H/T/413	**Embedded Systems**	**L T P C** **3 1 0 4**
Course Prerequisites	**ES/CM/TP104A, IEE/PC/B/T/215, IEE/PC/B/T/312**	
Objectives:	The course aims to provide adequate knowledge about ● The basics of Embedded Systems and Real Time Systems. ● The basics of embedded system development tools ● Atmel RISC Processors ● C programs for Microcontrollers ● The basicconcepts of RTOS ● The fundamentals of embedded Linux. ● The basics of amulticore microcontroller	
Course Outcome:	On completion of the course, the students will be able to CO1:**Describe** basics of embedded system development tools and Atmel RISC Processors (K1, A1). CO2: **Develop** C programs for Microcontroller applications. (K3, A3-adapt). CO3: **Describe**concepts of RTOS(K1, A1). CO4: **Describe**fundamentals of embedded Linux(K1, A1). CO5: **Describe**fundamentals of multicore microcontrollers (K1, A1)	
Unit I	**ATMEL RISC Processors and Development Tools: 10 hrsCO1** Introduction, Basics of developing for embedded systems, Atmel RISC Processors Architecture, Memory, Reset and interrupt functions, Parallel I/O ports, Timer/Counters, Serial communication using UART, SPI, AnalogInterfaces,Control statements, Multicore microcontroller.	
Unit II	**Elements of C Programming and Preprocessor Functions: 10 hrsCO2** Variables and constants, I/O operations, Operators and Expressions, Functions, Pointers and Arrays, Structure and Unions, Memory types, Real time methods, Standard I/O and Preprocessor functions	
Unit III	**IDE and Project Development: 10hrs CO2** Code Vision AVR C Compiler and IDE: IDE Operation, C Compiler Options, Compile and Make Projects, Program the target device, AVR code generator, Atmel AVR Studio debugger, Project development: Process steps, Example Projects Assignments on code development.	
Unit IV	**RTOS Internals: 10 hrsCO3** Introduction to RTOS: scheduler, objects, services, key characteristics, Tasks, Semaphores, Message queues, Pipes, Event Registers, Signals, Condition variables. Case studies on typical asks, Semaphores, Message queues, Piping applications.	
Unit V	**Embedded linux 10hrs CO4** Introduction - host-target development setup hardware support - development languages and tools – RT linux., Linux kernel and kernel initialization - system initialization – hardware support – bootloaders, Embedded development environment - GNU debugger - tracing & profiling tools - binary utilities - kernel debugging - debugging embedded Linux applications - porting Linux - Linux and real time - SDRAM interface. Case studies on kernel debugging - debugging embedded Linux applications	
Unit VI	**Multicore Microcontroller: 8 hrsCO5** Propeller Chip, Introduction to Propeller Programming, Debugging Code for Multiple Cores. Assignments on code development.	
Text Books	1) Qing Li with Caroline Yao "Real-Time Concepts for Embedded Systems " CMP books 2011 2) Barnett, Cox, &O'Cull "Embedded C Programming and the Atmel AVR" Thomson Delmar learning 2006	

Reference Books	1. KarimYaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "Building embedded linux systems", O'Reilly, 2008. 2. Christopher Hallinan, "Embedded Linux Primer: A practical real world approach", Prentice Hall, 2007. 3. Craig Hollabaugh, "Embedded Linux: Hardware, software and Interfacing", Pearson Education, 2002. 4. Doug Abbott, "Linux for embedded and real time applications", Elsevier Science, 2003. 5. Programming andcustomizing the multicore propeller microcontroller, Shane Avery , Chip Gracey, Vern Graner, Martin Hebel and Joshua HintzeMcGraw-Hill
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination
Course delivery format	Power point teaching and assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PC/H/ T/413 Embedded Systems	**CO 1**	**3**	**2**	**1**		**1**									**1**	
	CO 2	**1**	**3**	**2**		**2**									**2**	
	CO 3	**1**	**3**	**2**										**1**		
	CO 4	**1**	**3**	**2**										**1**		
	CO 5	**1**	**3**	**2**										**1**		

Course code: IEE/PC/H/S/411	POWER ELECTRONICS LABORATORY	L T P C 0 0 4 2
Course Outcome:	On completion of the course the students will be able to **CO1 :**Develop two part piecewise linear model of general purpose and Schottky rectifier diodes and apply the model parameters in rectifier circuits**(K3,A2-model,S2-build)** **CO2 :**Investigate the reverse recovery of general purpose and fast recovery silicon diodes**(K4, A3-recognize, S3-show)** **CO3 :**Develop single-phase, mid-tap, controlled rectifier circuits using SCRs with resistive and series connected resistive-inductive loads**(K3,A2-show, S2-build)** **CO4 :**Study the operation of Darlington transistor as a saturated switch with resistive load. **(A2, S3-demonstrate)** **CO5 :**Study the operation of DC to DC Converters and AC-side controlled battery charger**(A2, S3-demonstrate)**	
Syllabus :	1. Assignment on evaluation of Parameters of Piecewise Linear Model of Rectifier Diodes 2. Case study of Reverse Recovery in Rectifier Diodes 3. Case study of Switching Performance of a Darlington Transistor 4. Case study of a Single-Phase, Half-controlled Rectifier Circuit 5. Case study of an AC side controlled battery charger 6. Case study of a buck converter 7. Case study of a boost converter	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping: (3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/H/S/411: POWER ELECTRONICS LABORATORY		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**								**PSO 1**	**PSO 2**	**PS0 3**
	CO1	3	2	1		1								1		
	CO2	3	1	1		1								1		
	CO3	3	2	1	1	1								2	2	
	CO4	3	1	1		1								1	2	
	CO5	3	2	1	1	1								2	2	

Course code: IEE/PC/H/S/412	**TELEMETRY & REMOTE CONTROL LABORATORY**	**L T P C** **0 0 4 2**
Course Prerequisites	**IEE/PC/B/T/225**	
Course Outcomes:	On completion of the course, the students will be able to **CO1:** Demonstrate different analog modulation and demodulation systems. (K3, A2-examine, S3) **CO2:** Demonstrate different digital modulation and demodulation processes. (K3, A2-examine, S3) **CO3:**Study the concepts of time division multiplexing and demultiplexing systems.(A2,S2-operate) **CO4**: Simulate and study different modulation and demodulation systems using MATLAB.(K3-apply, A2)	
Syllabus :	1. Case study of the characteristics of AM and FM modulators and demodulators. 2. Case study of (1) pulse amplitude (2) pulse width and (3) pulse position modulation-demodulation Systems. 3. Case study of pulse code modulation-demodulation systems. 4. Case study of delta/adaptive delta modulation-demodulation systems. 5. Case study of the characteristics of (1)ASK, (2) FSK and (3) PSK (BPSK and QPSK) Systems. 6. Case study of a time division multiplexing system. 7. Case study of the performance of a phase locked loop as a detector. 8. Assignment of different modulation/demodulation systems using MATLAB	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

IEE/PC/ H/S/412: TELEMETRY & REMOTE CONTROL LABORATORY		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
	CO 1	2	1			3								2		
	CO 2	2	1			3								2		
	CO 3	2	1			3								2		
	CO 4	1	1			3								2		

Course code: IEE/PS/B/S/413	PROJECT I	L T P C 0 0 6 3
Course Prerequisites		
Course Outcome:	On completion of the course, the students will be able to CO1: Organize the planning and execution of a proposed engineering project (S2, A4-customize) CO2: Create/collect an engineering data base and/or develop advanced knowledge (K5, S5) CO3: Compile a scientific report. (K5, A5-represent) CO4: Display grasp of the chosen topic (A5)	
Syllabus:	Project on design, implementation and testing of an Electronic / Instrumentation / Control or Software system. The evaluation will be based on demonstration of the product, and oral as well as written presentation of the project report.	
Recommended by the Board of Studies on		
Date of Approval by the Academic Council		

CO-PO Mapping: (3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO1	PSO 2	PSO3
PROJECT I IEE/PS/B/S/413	CO 1	2	2	3	2	2	2			1	1			2	2	2
	CO 2	1	2	2	2	3								2	2	2
	CO 3		1	1		3									2	1
	CO 4	3	2	2	1	1								1	2	2

Course code: IEE/PE/B/T/421A	**Instrumentation in Space Technology**	**L T P C** **3 0 0 3**
Course Prerequisites	**IEE/PC/B/T/225, IEE/PE/B/T/41B**	
Objectives:	The course aims to provide adequate knowledge about a. Brief concept on astronomy; celestial body and navigation; stellar structure; Sun and solar phenomenologies b. Detailed description of azimuthal coordinates and measurements of spherical galaxy c. Description of selected astronomical instruments and their construction, working principles and uses d. Understanding of astronomical data processing	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe the astronomy; celestial body and navigation; stellar structure; Sun and solar phenomenologies(K2, A1). CO2: Describe the azimuthal coordinates and their measurement techniques (K2, A1). CO3: Explain the working principle of different types of astronomical instruments (K2-describe, A1). CO4: Describe the different methodologies of astronomical data processing.(K2, A1)	
Unit I	**Introduction:: 6hrs : CO1** star, stellar structure, planets, satellite, star formation, Celestial Coordinates, The Sun and Standard Solar Model, Solar Cycle, Solar Phenomenologies, History of astronomical instruments Assignments on the concepts of basic astronomy and astrophysics	
Unit II	**Basics of Azimuthal measurements: 8hrs : CO2** Basic parameters and their Azimuthal Measurements, unit and standard, ground based calibration and on-board calibration, Antenna Case study: Solar Irradiance Measurement System And Solar Radio Burst Detection	
Unit III	**Working principles of selected astronomical instruments: 22hrs: CO3** Some ground based instruments Telescope, type of astronomical and Solar telescope, Optical filter, CCD Camera. Solar Pyranometer, Solar Radio flux measurements, Spectrometer,., Ground based Observatory, Space Filght Particle instruments: Detector: Faraday Cups, Discrete Electron Multiplier, Continuous Electron Multiplier, Microchannel Plates, Solid-State Detectors, Energy Loss Of Particles In Matter, Silicon Solid-State Detectors, Scintillators And Cherenkov Radiators, Langmuir Probes, Mass Spectrometer Analyser: Retarding Potential Analyzer , Cylindrical Curved Plate Electrostatic Analyzer, Spherical Sector Analyzers, Solid-State Detector Telescopes, In-Flight Instrument Calibration and Performance Verification Electrostatic Analyzers (ESAs), Gain Degradation in Electron Multiplier Detectors, Time-of-Flight Detector Systems Case study : **Hubble telescope** Assignments on Analysers and Detectors	
Unit IV	**Astronomical Data Processing: 8hrs :CO4** Applications of standard data processing techniques for Time series Analysis: smoothing, filtering, Box Jenkins Methodology, Memory Analysis of time series data, forecasting, introduction to image processing Assignment on time series analysis	
Text Books	1)Field Guide to Astronomical Instrumentation, Author(s): Christoph U. Keller; Ramón Navarro; Bernhard R. Brandl, ISBN: 9781628411775, Volume: FG32 2)Mastering Python Data Analysis By Magnus VilhelmPersson, Luiz Felipe Martins, birmingham publisher 3)Astronomical instruments and their uses , Allan Chapman,Variorum, 1996 4) Time series analysis, forecasting and control, Book by George E. P. Box	

Reference Books	• Instrumentation for Large Telescopes:Jose M. Rodriguez Espinosa, Publisher: Cambridge University Press, DOI:https://doi.org/10.1017/CBO9780511564932 • Forecasting: Methods and Applications, John Wiley & Sons, 2008 • Statistics, Data Mining, and Machine Learning in Astronomy: A Practical Python Guide for Analysis of Survey Data By ŽeljkoIvezić, Andrew J. Connolly, Jacob T VanderPlas, Alexander Gray, Pricepton University Press
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination
Course delivery format	Primarily black board teaching and assignments
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications
Other learning activities	Group discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PE/B/T /421 A : Instrumentation in Space Technology	**CO 1**	**3**														
	CO 2	**3**	**2**		**1**											
	CO 3	**2**	**3**		**1**											
	CO 4	**2**	**2**			**3**									**1**	

Course code: IEE/PE/B/T/422A	Electronic Olfaction & Taste Sensing	L T P C 3 0 0 3
Course Prerequisites		
Objectives:	The course aims to provide adequate knowledge about ● Artificial smell and taste sensing systems ● Different types of instruments for smell and taste parameter measurements ● Sample handing for both the sensor systems ● Sensors for olfaction and taste sensing ● Instrumentation scheme for electronic nose and tongue ● Sensor response analysis system ● Combination of electronic nose and tongue	
Course Outcome:	On completion of the course, the students will be able to CO1: Explain and interpret artificial sensing system for smell and taste (K2, A1) CO2: Study different analysis techniques for handling sensor responses (K4,A2) CO3: Classify different types of sensors for smell and taste identification and apply combination of two sensing system(K2, K3,K4) CO4: Study several data handling & analysis techniques and high end instruments for volatile and liquid sample analysis(K2, A2-study)	
Unit I	**Introduction : 8hrs : CO1** Introduction to human olfaction and taste sensing mechanism, Nasal chemosensory detection, Thresholds for odour and nasal pungency, Psychometric functions for odour and nasal pungency,. Introduction to Electronic taste sensing system, Basic tastes Case studies for olfaction and taste sensing with real time examples	
Unit II	**Sample handling and delivery system: 8hrs :CO2** Physics of evaporation, Sample flow system, Headspace sampling, Diffusion method, Permeation method, electrochemical sensing methods, Case studies for typical sample handling methods with applications	
Unit III	**Sensors for olfaction and Taste sensing and Introduction to Combined sensing systems:16hrs :CO3** Survey and classification of chemosensors, Chemoresistors, MOS, Organic Conducting Polymers, Chemocapacitors, QCM, SAW, Optical odour sensors. Data level fusion, Feature level fusion, Decision level fusion, Fusion models Assignments on sensor fusion methodologies	
Unit IV	**Signal conditioning, pre-processing and analysis techniques & Instruments for chemical sensing: 14hrs :CO4** Interface circuits, Baseline manipulation, Normalization, Noise in sensors and circuits. Pattern recognition methods: Nature of sensor array data, Classification of analysis techniques. Statistical pattern analysis techniques: Linear Discriminant analysis, Principal component analysis, Cluster analysis. Intelligent Pattern Analysis Methods: Multilayer feedforward networks, Competitive feature mapping networks, Fuzzy based pattern analysis, Neuro fuzzy systems etc Gas Chromatography, Olfactometry –Static and dynamic, Environmental chambers. HPLC- Taste attributes, Electronic nose, Electronic Tongue Assignments on several data analysis techniques	
Text Books	1) Sensors and Sensory Systems for an Electronic Nose: J.W.Gardner	
Reference Books	1) Toko, Kiyoshi. Biomimetic sensor technology. Cambridge University Press, 2000	
Mode of Evaluation	Written CT-I & II and Assignments Final-Written Term End Examination	
Course delivery format	Power point teaching and assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	

Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PE/B/T /422 A: Electronic Olfaction & Taste Sensing	CO 1	3	2	1	1										1	
	CO 2	2	3	1			1								1	
	CO 3	2	3	1	1										1	
	CO 4	1	3	2	1	2									2	
	CO 5	1	3	2	1	2			1						2	

Course code: IEE/PC/H/T/423	Advanced Process Control	L T P C 3 1 0 4
Course Prerequisites	IEE/PC/B/T/223, IEE/PC/B/T/224,IEE/PC/H/T/313,IEE/PC/H/T/315	
Objectives:	The course aims to provide adequate knowledge about ● Discrete-time control systems; Analysis of SISO process control loop including stability analysis by z-transform technique. ● Digital implementation of PID controller and design of digital controllers. ● Multivariable and Adaptive control systems. ● Fuzzy and Neuro-Fuzzy Control systems.	
Course Outcome:	On completion of the course, the students will be able to CO1: Explain the various operational steps of digital control systems. (K2-describe, A1) CO2: Explain the dynamic and steady state behavior of discrete-time control systems. (K2-describe,A1) CO3: Explain the role of multivariable and adaptive control systems. (K2- describe, A1) CO4: Discuss intelligent control systems with fuzzy and neuro-fuzzy models. (K2 describe, A2)	
Unit I	**Introduction to Discrete-Time Control Systems : 10hrs : CO1** Sampled-data control system: Digital Computer as a controller in process control loop, advantages and disadvantages of sampled-data control systems, discrete time signal, sampling of continuous signal, signal reconstruction – zero-order and first-order holds, modeling of digital control systems – models for ADC and DAC, solution of difference equation using z-transform. Overview of computer process control systems.	
Unit II	**z-Plane Analysis of Discrete-Time Control Systems : 24hrs : CO2** Pulse transfer function, analysis of SISO process control loop by z-transform technique, z-and s-domain relationship, stability analysis of discrete systems, Jury's stability test, stability analysis by using Bilinear transformation, assignments on the stability analysis for sampled data control systems, steady state error analysis of sampled data control systems, Digital implementation of PID controllers - case studies, Design methods of sampled data control systems. Discrete state space models. Controllability and observability of discrete time systems.	
Unit III	**Basics of Multivariable and Adaptive Control Systems : 12hrs : CO3** Multivariable control system: Loop interaction, Pairing controlled and manipulated variables, Design and tuning of Decouplers, Tuning multivariable control systems. Concepts of Adaptive control – gain scheduling, self-tuning and model reference adaptive control, Case studies on adaptive PID controllers.	
Unit IV	**Fuzzy and Neuro-Fuzzy Control: 10hrs : CO4** Overview of fuzzy logic: Fuzzy set, Membership function, Fuzzy Rules, Fuzzy inference. Fuzzy logic controller (FLC) – block diagram and computational steps, design steps of FLCs, merits and limitations of FLC design. Adaptive Fuzzy controllers - case studies on adaptive fuzzy controllers. Neuro-fuzzy control: Models of a neuron, Multilayer feedforward networks – architecture and learning, models of neuro-fuzzy control systems and computational steps - case studies on neuro-fuzzy controllers.	
Text Books	1) Discrete-Time Control Systems, K. Ogata, Prentice-Hall Inc. (2nd .ed.) 1995 2) Process Dynamics and Control, Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle, John Wiley & Sons, (3rd ed.), 2010 3) Neuro-Fuzzy and Soft Computing, A Computational Approach to Learning and Machine Intelligence, J.-S.R Jang., C.-T Sun., & E. Mizutani, Prentice Hall, Upper Saddle River, NJ, 1997	
Reference Books	1)Digital Control Systems, B.C. Kuo, Prentice-Hall, 1992 2)Fuzzy Logic with Engineering Applications, T. J. Ross, McGraw-Hill, Inc., 1995 3)Tuning of Industrial Control Systems, A.B. Corripio, ISA Society (2nded.) 2001	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Black board teaching, PPT presentation, and tutorial assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	

Supporting Laboratory course	
Recommended by the Board of Studies on	
Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/H/ T/423: Advanced Process Control	**CO 1**	3	1												1	
	CO 2	2	1	3											2	
	CO 3	2	2	3		1									2	
	CO 4	1	2	3		1									2	

Course code: **IEE/HS/B/Eco/T/421**	**Economics**	**L T P C** **3 0 0 3**
Course Prerequisites		
Objectives:	The course aims to provide adequate knowledge about ● Role of economics in engineering and technology ● Preliminary idea behind utility, demand, production and supply ● Different types of market and cost in present economic scenario ● Nature and behavior of Indian economy	
Course Outcome:	On completion of the course, the students will be able to CO1: Describe and explain the importance of economics in technology (K2, A1) CO2: Understand the relation between demand, production and supply in an economic environment (K2, A1-recognize) CO3: Describe the role of market and types of cost in the context of economics (K2, A1) CO4: Study the characteristics of Indian economy. (K2-review, A2)	
Unit I	**Introduction: 4Hrs:: CO1** Definition of Economics, Nature of Economic problem, Production possibility curve, Economic laws and their nature, Relation between Science, Engineering, Technology and Economics	
Unit II	**Utility: 6Hrs:: CO2** Concepts and measurements of utility, Law of Diminishing Marginal Utility- its practical application and importance. Case studies on Law of Diminishing Marginal Utility.	
Unit III	**Demand: 6Hrs:: CO2** Meaning of Demand, Individual and market demand schedule, Law of demand, Shape of demand curve, Elasticity of demand, Measurement of elasticity of demand	
Unit IV	**Production: 6Hrs:: CO2** Meaning of production and factors of production, Law of variable proportions, Returns to scale, Internal and external economics and diseconomics of scale	
Unit V	**Supply:4 Hrs:: CO2** Supply and Law of Supply, Role of demand and supply in price determination, Effect of changes in demand and supply on prices. Typical case studies.	
Unit VI	**Market:6 Hrs:: CO3** Meaning of market, types of market-Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition, main features of these markets	
Unit VII	**Cost: 8Hrs:: CO3** Various concepts of cost-fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, total cost etc. in short run and long run	
Unit VIII	**Elementary idea about Indian economy:4 Hrs:: CO4** Nature and characteristics of Indian economy, Meaning of privatization and its merits and demerits, Globalization of Indian economy and its merits and demerits, Elementary concepts of taxation structure like GST, WTO, GATT & TRIPS agreement	
Text Books	1) P. N. Chopra, “Principles of Economics”, Kalyani Publishers. 2) K. K. Dewett, “Modern Economic Theory”, S. Chand Publisher.	
Reference Books	1) S. K. Mishra, “Modern Micro Economics”, Pragati Publications. 2) A. B. N. Kulkarni and A. B. Kalkundrikar, “Economic Theory”, R. Chand & Co. Publisher	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	
Course delivery format	Primarily black board teaching and tutorial assignments	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications	
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples	
Supporting Laboratory course		
Recommended by the Board of Studies on		

Date of Approval by the Academic Council	

CO-PO Mapping:(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/HS/B/ Eco/T/421 Economics	CO 1						1		1			3				1
	CO 2	2	3						1			2				1
	CO 3	2	3						1			2				1
	CO 4								1			3	2			1

Course code: IEE/PC/B/S/421	PROJECT II	L T P C 0 0 9 4.5
Course Prerequisites		
Course Outcome:	On completion of the course, the students will be able to CO1: Organize the planning and execution of a proposed engineering project (S1, S2, A4-customize) CO2: Create/collect an engineering data base and/or develop advanced knowledge (K5, S5) CO3: Validate the data /observations and compile a scientific report. (K6, A5) CO4: Display grasp of the chosen topic (A5)	
Syllabus:	Project on design, implementation and testing of an Electronic / Instrumentation / Control or Software system. The evaluation will be based on demonstration of the product, and oral as well as written presentation of the project report.	

CO-PO Mapping: (3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
PROJECT II IEE/PC/B/S/421	CO 1	2	2	3	2	2	2			1	1			2	2	2
	CO 2	1	2	2	2	3								2	2	2
	CO 3		1	1		3									2	1
	CO 4	3	2	2	1	1								1	2	2