Bachelor of Instrumentation and Electronics Engineering (Syllabus)

Bachelor of Instrumentation and Electronics Engineering
(Effective for 2020-2024 and 2021-2025)

Course code: FET/BS/B/Math/T/ 211	**Mathematics-III**	**L T P C** **2 1 0 3**
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.	
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;	
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	
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.	
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.
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		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
	CO1	**3**	**2**	**1**	**1**											
	CO2	**3**	**2**													
	CO3	**3**	**2**	**1**	**1**											
	CO4	**3**	**2**	**1**	**1**											
	CO5	**3**	**2**	**1**	**1**											
	CO6	**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.	
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.	
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.	
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.	
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.	
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	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/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.	
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.	
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,	
Text Books	1) Transducers and Instrumentation, D. V. S. Murthy, Prentice-Hall Inc. (2nd ed.), 2010. 2) Introduction to Measurements and Instrumentation, A. K. Ghosh, Prentice-Hall Inc. (4th ed.), 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	Class 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	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PC/B /T/213: FUND OF INSTRU MENTATI ON	**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	
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	
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.	
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	
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	
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 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)

IEE/PC/B/T/214: Electronic 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	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 1 0 4**
Course Prerequisites		
Objectives:	The course aims at providing adequate knowledge on • 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, 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)** **CO4:** categorize different types of memory elements; integrate them to develop different sequential logic circuits. **(K4, A2)**	
Unit I	**Positional Number Systems and Codes: 4 hrs. :: CO1** Number systems and codes - Positional number system, Radix conversio; 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 : 20 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. Integrated Circuit Logic Families - TTL, PMOS, NMOS, CMOS.	
Unit IV	**Sequential Logic Design : 18 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, Sequence generator. 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 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)

		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/215: Digital Electronics	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	
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.	
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)	
List of Experiments:	Design and verification (both logic as well as timing) 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: Study and operate electronic test and measuring equipment (Multimeter, Oscilloscope, Function generator, Desktop Regulated Power Supply) and indicators, recorders, annunciation systemsand 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)	
List of Experiments:	1. Study/Application of electronic test and measuring equipments: Multimeter, Oscilloscope, Function generator Desktop Bipolar Regulated Power Supply (CO1) 2. Elementary printed circuit board design using a PCB Art work Software (e.g. easy pcb) (CO2) 3. Introduction to an electronic design and simulation package (e.g. TINA CAD student version). (CO2) 4. Acquaintance with an Instrument panel (Study of the different type's instrument placement, mounting of various accessories, layout and wire harnessing etc. into a panel). (CO3) 5. Study of some process instruments: a) pressure gauge, b) flow device, c) level measuring device, d) temperature transducers (CO3) 6. Fabricate and Study of D.C. Biasing of (Q-point determination, selection of components etc.): a) Zener diode; b) BJT; c) FET; (CO4) 7. Study of some electronic application circuits a) E.M. Relay driver circuit; b) Application of Optical Isolator etc. (CO4) 8. Study of Voltage Regulations : a) Zener Diode Regulator; b) Transistorized Series Regulator; c) Short circuit Protection etc. d) I.C. regulator (CO4)	
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/ 212: Electronic and Instrument Workshop		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	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 presentation on a topic that relates to the course curricula, preferably on recent technological advances or current developments.	
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/PC/B/S/213: Seminar	**CO1**	1	2				2	2				2	3		1	1
	CO2	1	2				2	2	2		3	2				
	CO3		2			1	2	2			3	2			1	1
	CO4		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 analyze algorithms (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 and encapsulation mechanisms. (A1, A3, K2, K3) CO5: Illustrate the extended features of OOPs (Inheritance, Polymorphism, Operator overloading) 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)	
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).	
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.	
Unit VI	**Searching:** Sequential search, Binary search, Interpolation search.	
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	
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 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/221: Data Structure, Algorithms & OOPs	**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 at providing adequate knowledge on * 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. **(K2, K3, A3)** **CO3:construct** and **analyze** various nonlinear analog circuits, e.g. comparators with positive feedback, multivibrators, oscillators, other waveform generators, active filters, precision rectifiers, etc. **(K2, K3, A3)** **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: 4 hrs :: 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 : 18 hrs :: 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**: **18 hrs ::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 problems.	
Unit IV	**Practical Op-Amp limitations, Timer application and ADC-DAC: 8 hrs :: 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 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/B/S/221 ANALOG ELECTRONOICS LABORATORY** 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 & monostable multivibrators 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)

		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/222: Analog Integrated Circuits	**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 techniques and devices used in process industries.(K2-describe,A1) CO2: Describe the operating principle of sensors used to measure position, displacement, velocity and acceleration. (K2,A1) CO3: Describe the operating principles and outline the application aspects of pressure measurement systems.(K2, A1) CO4: Explain the operating principle of force and torque measurement systems.(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.
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.
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.
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.
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 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 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.	
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.	
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.	
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.	
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, 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.	
Unit VII	**Introduction to Design : 6hrs: CO4** The design problem, Concepts of cascade and feedback compensation, Realization of basic compensators, Case studies.	
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	1) Modern Control Engg, K. Ogata, Prentice-Hall Inc. (3rd.ed.), 1997.	

Books	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	Class discussions, Group 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)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
IEE/PC/B/T/224: Linear Control Systems	**CO1**	**3**	**1**													
	CO2	**2**	**3**	**1**												
	CO3	**1**	**3**	**2**	**1**										**1**	
	CO4	**2**	**2**	**3**	**1**	**1**									**1**	

Course code: IEE/PC/B/T/225	**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	
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.	
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.	
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.	
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.	
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.
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	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
IEE/PC/B/T /225: 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/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	
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)	
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	
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	
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, Serial data transmission standards: RS232, RS422, RS 485 Parallel data transmission standards: IEEE 4888	
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		

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)	
List of Experiments:	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 & monostable multivibrators 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)

		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/S /221: Analog Electronics Laboratory	**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)	
List of Experiments:	List of experiments: 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	PO10	PO11	PO12	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	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: Describe few special techniques like Conductivity, 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.	
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.	
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 λ -ranges, Colorimetry, Atomic Spectral Methods: Emission and Absorption: Visible, UV and X-rays; sources, principles, detectors, sample preparation etc., 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,	
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	
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, 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 /311: 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/H/IT/T/312	**Computer Organization, Architecture and Networking**	**L** 3 **T** 1 **P** 0 **C** 4
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 examine the 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	
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	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
IEE/PC/H/IT/ T/312: Computer Organization, Architecture and 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/PC/B/T/313	**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 and flow sensors/ measurement systems used in process automation • Smart field devices used in process plants and the communication protocols used by such devices	
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 used in process industries CO2: Explain the principle and the signal conditioning techniques of temperature sensors CO3: Describe the operating principle and the application aspects of flow measurement systems CO4: Explain the features and communication protocols of smart field devices.	
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, conductivity level sensors, radiation level sensors, vibrating level switches. Tank gauging systems	
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 simulators and calibrators.	
Unit III	**Flow Measurement: 16hrs: CO3** 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 of flowmeter.	
Unit IV	**Introduction to Smart Field Devices: 4hrs:: CO4** Smart transmitters - features & advantages, HART protocol. Interfacing to control devices. Overview of field device networks - Field bus, Ethernet APL.	
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, 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 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 /313: 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/PC/B/T/314	**Microcontrollers**	**L** **3**	**T** **0**	**P** **0**	**C** **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-bitmicrocontroller(K2, A2-study) CO2:Developanddebugassemblylanguage/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:Illustratetheinterfacingofperipheraldevices,viz.ADC,DAC,RTC,DisplayController and Keyboard(K3,A2-study)				
Unit I	Introduction to microcontrollers:8hrs:CO1 Basicintroduction.Microcontrollersvs.Microprocessors.Hardwarearchitecture,memory organization and Timing and themachinecycleofIntel8051microcontroller.				
Unit II	Introduction to microcontrollerprogramming:10hrs:CO2 Overviewof8051instructionsetandintroductiontoassemblylanguageprogramming.Introductionto Keil Ccross-compiler. Assignments on code development.				
Unit III	Understanding the microcontroller on-chip modules:10hrs:CO3 Understanding the functioning of the on-chip timers, interrupts, and serial port of the 8051microcontroller. Developing codes for running the on-chip modules. Case studies on typical interrupt-driven timer and serial port applications.				
Unit IV	Developmentofastand-alonemicrocontrollerboard:14 hrs:CO4 Basic overview of selected off-the-shelf ADC, DAC and Display Controller. Case studies on ADC, DAC applications.				
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, MykePredko, 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)

		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/T /314: Microcontrollers	**CO 1**	**3**	**2**	**1**												
	CO 2	**2**	**3**		**1**	**2**										
	CO 3	**3**	**2**		**1**									**1**	**1**	
	CO 4	**1**	**2**	**2**	**3**	**1**								**2**	**1**	

Course code: IEE/PC/B/T/315	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: Explain and 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 : 8hrs : 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.	
Unit II	**Control actions: 10hrs: CO2, CO3** Modes of control actions – on-off, P, PI, PID, Different forms of PID controllers, Characteristics of process response under different types of controllers, Reset windup. Positional and velocity form of PID controllers. Auto/manual transfer.	
Unit III	**Schemes and analysis of process control strategies:16hrs: CO2, CO3** Behavior of a typical closed-loop process control systems. PID control – design and tuning, Feed forward control, Ratio control, Cascade control, Split-Range control, Selector control, Anti-reset control. Dead-time compensation – Smith predictor.	
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.	
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/315: 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/316	**Signal Transmission and Communication Systems**	**L T P C** **3 0 0 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.	
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.	
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.	
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.	
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		
Supplementary academic support		
Other learning activities		
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/ 316: Signal Transmission and Communication Systems		**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**	**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/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 2nd 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)	
List of Experiments:	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 2nd 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)

IEE/PC/B/S/ 311: Control Systems 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**	**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 an analog two wire transmitter and evaluate its features CO2: Interpret the data-sheet, calibrate and test the performance of position, displacement, velocity, pressure, level, temperature, force and acceleration sensors/transmitters CO3: Assemble electro-pneumatic components and pneumatic actuators to construct a simple pneumatic actuating systems and evaluate its performance CO4: Configure/parameterize HART compliant smart transmitters (A5-Characterize, S5-Construct)	
List of Experiments:	1. Testing, evaluation and calibration of a 2-wire V to I converter. 2. Study, calibration and signal conditioning of a LVDT. Study of inductive, capacitive, optical and magnetic proximity sensors and accelerometers. 3. Measurement of RPM using incremental shaft encoder/ proximity sensor and stroboscope. 4. Calibration of a pressure gauge, pressure switch and a pressure transmitter using a pneumatic calibrator / dead weight tester. 5. Calibration of level/temperature sensors and transmitter. 6. Study and calibration of a strain/force measuring system and testing of the associated electronics used to construct a weighing system. 7. Configuration and parameterization of a HART compliant, smart pressure/ temperature/level transmitter 8. Study of pneumatic actuators, electro-pneumatic components and a positioned. Assembly and testing of a simple pneumatic actuating 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)

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 HDL. **(K2, S1-organize)** **CO2:** organize HDL 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)**	

List of Experiments:

Mini Projects on digital circuits of different complexities (eg. Priority encoder, arbitrary sequence counter, sequence detector, sequence generator, multiplier, ALU etc.) using VHDL/Verilog 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.

Assignments :

1. Realize a prime BCD detector. The input is a single BCD digit. If it is prime the output will be 1, otherwise 0.
2. (a) Realize a half-adder. (b)Using this as a component, realize a full-adder. (c) Realize a Half-subtractor; (d) Using the designed Half-adder and Half-subtractor as modules and one basic logic gate (if needed), realize a Full Subtractor.
3. Realize a cascadable four-bit unsigned BCD adder. Using this as a component, realize a 2-digit BCD adder.
4. Realize one SR-Latch with asynchronous Set and Reset facilities. Use behavioural description.
5. Realize one SR-FF with asynchronous Set and Reset facilities. Use behavioral description. Use this as a component to realize a JK-FF with asynchronous Set and Reset facilities.
6. Realize a MOD-4 synchronous binary counter. Cascade two such counters to realize a MOD-16 counter. List the count states for this cascaded counter.
7. Realize a 4-bit PISO with “L/Sbar” control signal. At the rising edge of the clock signal if “L/Sbar” is 1, the external data is loaded onto the register and if it is 0 the register data is shifted right by one bit.
8. Realize a sequence generator which generates the sequence ..,1,0,1,1,0,0,.. repeatedly at successive rising edges of the clock signal.
9. Realize a frequency f_{clk}/N, where f_{clk} is the input clock frequency and N is a 4-bit input number.
10. Realize a synchronous sequential circuit which produces a logic 1 output when it detects “11” input sequence and produces logic 0 output when it detects “00” input sequence. For other sequences last output condition is maintained. The input should come from a 20-bit Pseudo-Random Bit Sequence generator.
11. Realize one 4-bit unsigned multiplier using shift-and-add scheme.
12. Realize a miniature 4-bit unsigned ALU which performs the following operations depending upon a 4-bit op-code “OP” :

OP	**Action**
0000	NOP
0001	Add two operands (operand1 + operand2)
0010	Subtract two operands (operand1 – operand2)
0011	Bit-wise AND the two operands
0100	Bit-wise XOR the two operands
0101	Bit-wise OR the two operands
0110	Generates the 2s-complement of the operand1
0111	Bit-wise inverts the operand1
1000	Shift operand1 left by operand2 bits. (operand2 < 4)
1001	Shift operand1 right by operand2 bits. (operand2 < 4)

1010	Rotate operand1 left by operand2 bits. (operand2 < 4)
1011	Rotate operand1 right by operand2 bits. (operand2 < 4)

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/PC/H/T/321	**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, steady state error analysis of sampled data control systems, Digital implementation of PID controllers, 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. Neuro-fuzzy control: Models of a neuron, Multilayer feedforward networks – architecture and learning, models of neuro-fuzzy control systems and computational steps.	
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/321: 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/PC/H/T/322	**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, halfcontrolled bridge converter, regenerative converters.	
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.	
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)

IEE/PC/H/T/322: Power Electronics		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3														
	CO2	3	2												1	
	CO3	1	3			2									2	
	CO4	2	3												2	

Course code: IEE/PE/B/T/323A	Industrial Automation Systems	L T P C 3 0 0 3
Course Prerequisites	IEE/PC/B/T/313, IEE/PC/B/T/314	
Objectives:	The course aims to provide adequate knowledge about • Programmable Logic Controllers (PLC) and Distributed Control Systems (DCS) used for process and factory automation. • AC variable speed drives. • Smart field devices used in process industries and their communication protocols. • The use of industrial automation systems in hazardous locations and the techniques of explosion protection.	
Course Outcome:	On completion of the course, the students will be able to CO1: Explain PLC architecture, select hardware and program PLCs using IEC 61131 languages. CO2: Explain the operating principle, features, and application aspects of AC variable speed drives. CO3: Provide an overview of the hardware, functional, networking and programming aspects of a DCS. Explain the features of smart field devices and their communication protocols. CO4: Identify and categorize hazardous locations and explain techniques used for prevention of explosion due to electrical equipment.	
Unit I	**Introduction to Programmable Logic Controllers: 15hrs: CO1** Automation pyramid and the function of each level. PLC system architecture and hardware, interfacing sensors and actuators. PLC tags. Program scan cycle. Programming blocks and modes of program execution. IEC 61131 programming languages, data types, instructions, function blocks. Linear and structured programming. Remote I/O, PLC networking and communication protocols, hardware redundancy and fault tolerance. Differences between PLC and PAC (programmable automation controller). Basic components of a SCADA system, HMI software - features, visualization tools.	
Unit II	**AC variable speed drives-operating principles and applications**: **8hrs : CO2** Induction Motor fundamentals. Features of AC Drives and its benefits in motor control, types of AC Drives, block diagram and hardware components, operating principle, various control modes, interface and communication options. Configuration / parameter programming. Installation considerations. Harmonics and its reduction methods.	
Unit III	**Overview of Distributed Control Systems and Smart Field Devices: 10hrs: CO3** Distributed Control Systems: Features and applications, basic components, architecture, redundancy and fault tolerance, communication protocols and networking, I/O and controller configuration, function block programming, operator interface - features, visualization tools. Smart field devices - features, interfacing to control systems, communication protocols: HART, Fieldbus, Ethernet APL.	
Unit IV	**Hazardous locations and techniques used for explosion protection: 10hrs:: CO4** Industrial automation systems in hazardous locations: Area, material, and temperature classification. Explosion protection – intrinsic safety, explosion proof enclosures, pressurization. Relevant IEC standards. Equipment and Enclosure classification.	
Text Books	1) Principles of Industrial Instrumentation, by D. Patranabis, Tata McGraw Hill	
Reference Books	1) "Automating Manufacturing Systems with PLCs" by Hugh Jack 2) "Electric Motors and Drives: Fundamentals, Types and Applications" 5th Edn, by Austin Hughes and Bill Drury 3) “ABB Drives: Technical Guide Book” https://library.e.abb.com/public/df559f6df460420c8a0b14d07d109263/TechnicalGuideBook_EN_3AFE64514482_RevI.pdf 4) “Basic concepts for explosion protection” by Bartec, https://www.bartec.nl/downloads/safety-academy/ex-protection.pdf 5) “Practical Distributed Control Systems: For Engineers and Technicians” by IDC Technologies.	
Mode of Evaluation	Written CT-I & II Final-Written Term End Examination	

Course delivery format	Presentations, 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 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/324
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: Industrial Automation Systems	**CO 1**	**1**				**3**									**1**	
	CO 2	**1**				**3**									**1**	
	CO 3	**1**				**3**									**1**	
	CO 4	**1**				**3**									**1**	

Course code: IEE/PE/B/T/324A	**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 interpret the 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.	
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.	
Unit III	**Differential Amplifiers:10Hrs:: CO2** Basic differential pair, Common mode response, Differential pair with MOS loads, Illustrative examples.	
Unit IV	**Current Mirrors: 6Hrs:: CO3** Basic current mirrors, Cascode current mirrors, active current mirrors, Illustrative examples.	
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 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)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
IEE/PE/B/T/324A: Analog MOS Circuit Design	CO1	2	1	3	1	1									2	
	CO2	2	1	3	1	1									2	
	CO3	3	1	1	1	2									1	
	CO4	3	2	1											2	

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)	
List of Experiments:	MATLAB Review, Sequences, Operations with sequences, Linear Convolution, Synthesis of Sinusoidal Signals, The Sound Command, Multiplication of Sinusoids: Beat Notes, Amplitude Modulation. 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 Filter, A simple high pass filter: the Moving Difference Filter, Design of echo filters, Audio experiments. Frequency Resolution, Rectangular and Hamming Windows, Leakage, Bias, DTMF tones. White Noise. Peak Filters. Detection of Sinusoidal Signals Buried in Noise. Filter Design by Pole-Zero Placement. 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)

		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/S/ 321: Digital Signal Processing Laboratory	**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	

<table>
<tr><td>Course code:
IEE/PC/B/S/322</td><td>Process Control Laboratory</td><td>L T P C
0 0 3 1.5</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2"></td></tr>
<tr><td>Course Outcomes:</td><td colspan="2">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)</td></tr>
<tr><td>List of Experiments:</td><td colspan="2">1. To study Process controls from open loop to close loop PID control with PCS327 bench.
i) Experiment1: To study open loop characteristics of 2 step control process
ii) Experiment 2: To study the response of open loop proportional control system
iii) Experiment 3: To measure the response of a simple closed loop system
iv) Experiment 4: To analyze the proportional control action on closed loop system.
v) Experiment 5: To analyze the Integral control action on closed loop system.
vi) Experiment 6: To analyze the Derivative control action on closed loop system.
vii) Experiment 7: To analyze the response of proportional plus integral control action on closed loop system.
viii) Experiment 8: To analyze the response of proportional plus integral plus Derivative control action on closed loop system.
2. Study of Temperature measurement and control for flowing fluid through duct.
i) Experiment1: To study closed loop characteristic of 2 step control process
ii) Experiment 2: To study the response of close loop proportional control system
3. Process instrument calibration and implementation for the Tank level measurement and control
i) Experiment1: To study the calibration of tank level into 4-20ma
ii) Experiment2: To study closed loop characteristic of 2 step control process
iii) Experiment 3: To study the response of close loop proportional control system
iv) Experiment 4: To study the response of close loop proportional plus integral control system
v) Experiment 5: To study the response of close loop proportional plus integral plus derivative control system
4. Process instrument calibration and implementation for the temperature measurement and control of an heat exchanger
i) Experiment1: To study the calibration of heat exchanger temperature into 4-20ma
ii) Experiment2: To study closed loop characteristic of 2 step control process
iii) Experiment 3: To study the response of close loop proportional control system
iv) Experiment 4: To study the response of close loop proportional plus integral control system
v) Experiment 5: To study the response of close loop proportional plus integral plus derivative control system
5. Process instrument calibration and implementation for the Pressure measurement and control
i) Experiment1: To study the calibration of tank pressure into 4-20ma
ii) Experiment2: To study closed loop characteristic of 2 step control process
iii) Experiment 3: To study the response of close loop proportional control system
iv) Experiment 4: To study the response of close loop proportional plus integral control system
v) Experiment 5: To study the response of close loop proportional plus integral</td></tr>
</table>

	plus derivative control system
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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**	**PO10**	**PO11**	**PO12**	**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 connect to a PC for data I/O through a serial link (K3,A4,S4)	
List of Experiments:	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 μ Vision debug modes and the user interface for testing applications; case studies on code debugging. 3. Group assignments on writing simple assembly language and Cprogram 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 interfacing the on-board Keyboard, relay bank and LCD Display Controller IC for data I/O 6. Group assignments on data transfer to a PC for storage	
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	PO1 0	PO1 1	PO1 2	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**	

<table>
<tr><td>Course code:
IEE/PS/B/S/324</td><td>Mini Project (Automation Laboratory)</td><td>L T P C
0 0 6 3</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">IEE/PC/B/T/313, IEE/PC/B/T/314</td></tr>
<tr><td>Course Outcomes:</td><td colspan="2">On completion of the course, the students will be able to
CO1: Write and test simple programs using IEC 6113-3 programming languages and develop a PC based human-machine interface for operation and monitoring.
CO2: Develop logic, program and commission simple PLC based automation tasks using physical or simulated 3D machines and processes.
CO3: Connect pneumatic actuators and electro-pneumatic components and interface them to a PLC.
CO4: Configure, parameterize and evaluate the performance of a Variable Frequency Drive.</td></tr>
<tr><td>List of Experiments:</td><td colspan="2">A. Introductory Assignments:
1. Familiarization with the Codesys Development System and Codesys Soft PLC (Control WinV3 X64).
2. Familiarization with Siemens TIA Portal, Siemens PLC S7-1200 hardware, I/O interfacing, PLC configuration usingTIA Portal, I/O addressing, scan time,I/O monitoring and forcing.
3. Introduction to basic IEC 61131 programming concepts: Data types, logic operations, latches, edge detection, timers, counters, shift and rotate operations, use of function blocks and different modes of user program execution.
4. Programming and testing of a PC based Human Machine Interface and interfacing it with a PLC for real time operation and monitoring.
B. Students will develop logic, IEC 61131-3 compliant code, input/output interfaces and an HMI for the following PLC based mini projects:
1. 2-channel Alarm Annunciator.
2. Triple redundant measurement system using 2-out-of-3 voting / median selector logic and detection of the faulty input.
3. Basic sequence-of-event-detector.
4. Measurement of angular displacement and direction of rotation using an Incremental Encoder and quadrature decoding logic.
5. Automatic traffic signaling system for use at a road intersection.
6. ON-OFF tank level controller with Auto/Manual modes of operation, safety interlocks, alarm annunciation, trending and HMI for monitoring and operation.
7. Automatic liquid vending machine with the option of selecting the desired volume / price of the liquid being dispensed.
8. Assembly and testing of a simple pneumatic actuating systems operated by a PLC.
9. Digital servo that controls the panning motion of a motorized turntable.
10. Simplified, 5-floor elevator controller with the display of the elevator location.
11. Close loop control of a sorting conveyor / tank level / bottle filling plant using physical / simulated 3D (using Factory IO software) machines and processes.
12. Introduction to basic PLC networking.
C. Configuration, parameterization and commissioning of an induction motor speed control system using a Variable Frequency Drive (Siemens G120).
D. Study of symbols and terminologies used in P & I diagrams and drawing a P & I diagram using a CAD package.</td></tr>
<tr><td>Recommended by the Board of Studies on</td><td colspan="2"></td></tr>
<tr><td>Date of Approval by the Academic Council</td><td colspan="2"></td></tr>
</table>

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/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 Laboratory)**	**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)	
List of Experiments:	List of experiments to be tested and verified using Xilinx FPGA 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 5. Implementation of different edge detection algorithms 6. Implementation of different binarization 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)

IEE/PS/B/S/325: Mini Project (FPGA 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	**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/316	
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 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: Discussand 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.	
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.	
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	
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.	
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/B/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)

IEE/PC/ H/ T/411: TELEMETRY AND REMOTE CONTROL		**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**	**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/HS/B/Eco/T/412	**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	
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	
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/412: 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/PE/B/T/413 A	**DIGITAL IMAGE PROCESSING**	**L T P C** **3 0 0 3**
Course Prerequisites	**IEE/PC/B/T/225**	
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 theirapplications (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	
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	
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	
Unit VII	**Image segmentation:4hrs:CO3** Detection of discontinuities, edge linking and boundary detection, region based segmentation	
Unit VIII	**Image compression:6hrs:CO3** Importance of image coding and compression, image compression models, loss-less and lossy compression,	
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 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/413A: Digital Image Processing		**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**										**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/PE/B/T/413B	**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	
Unit II	**Different power plants : 8hrs : CO2** Salient features of instrumentation in nuclear, hydroelectric and non-conventional power plants.	
Unit III	**Safety measures : 8hrs : CO3** Instrumentation for safety-interlocks, protective devices; emergency measures; alarms and alarm analysis, monitoring of environmental pollution.	
Unit IV	**Data handling systems : 8hrs : CO4** Data-handling systems-data acquisition, processing, accounting, logging and display-storage systems.	
Unit V	**Basic concept of power plant simulators : 6hrs : CO4** Introduction to power plant simulators.	
Text Books	1) The control of boilers, Sam G. Dukelow, 2ndedition, 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 /413B: Power Plant Instrumentation		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3														
	CO2	3	1		1			1								
	CO3	2						3								
	CO4	2	1			3		2								

Course code: IEE/PE/B/T/413C	**Embedded Systems**	**L T P C** **3 0 0 3**
Course Prerequisites	**ES/CM/TP104A, IEE/PC/B/T/215, IEE/PC/H/T/314**	
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	
Unit IV	**RTOS Internals: 10 hrsCO3** Introduction to RTOS: scheduler, objects, services, key characteristics, Tasks, Semaphores, Message queues, Pipes, Event Registers, Signals, Condition variables	
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	
Unit VI	**Multicore Microcontroller: 8 hrsCO5** Propeller Chip, Introduction to Propeller Programming, Debugging Code for Multiple Cores	
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)

IEE/PE/B/T/413C: Embedded 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**									**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/PE/B/T/414A	Intelligent Control Systems	L T P C 3 0 0 3
Course Prerequisites	**IEE/PC/B/T/223, IEE/PC/B/T/224, IEE/PC/H/T/315**	
Objectives:	The course aims to provide adequate knowledge about • Understanding of the functional operation of a variety of techniques specific to intelligent control systems • The control/theoretic foundations • Analytical approaches to study their properties • Development of intelligent control systems	
Course Outcome:	On completion of the course, the students will be able to CO1: Discuss the various approaches of Intelligent control systems for engineering problems. (K2-describe,A2) CO2: Describe the design aspects of fuzzy logic controllers and their different operational modes. (K2, A1) CO3: Explain the functional operation of different neural network models and neuro-fuzzy control systems. (K2-describe, A1) CO4: Discuss some nature inspired algorithms based optimization of controller and model parameters. (K2-describe, A2)	
Unit I	**Introduction to Intelligent Control Systems**; **6hrs: CO1** Intelligent control requirements and architectures. Approaches to intelligent control. Knowledge based systems. Soft computing constituents; Fuzzy Logic, Neural Networks, Genetic Algorithm. Soft computing tools in intelligent control systems. Fuzzy and neuro-fuzzy control. Optimization of intelligent control systems.	
Unit II	**Fuzzy Logic System**; **18hrs : CO2** Introduction to crisp sets and fuzzy sets, basic fuzzy set operation. Membership function formulation and parameterization; Fuzzy inference mechanisms. Introduction to fuzzy modeling and control: Fuzzification, inferencing and defuzzification. Structures of Fuzzy Control Systems: Mamdani fuzzy controllers; Takagi/Sugeno fuzzy controllers; Types of fuzzy controllers – PI/ PD/and PID. Tuning of fuzzy controllers. Stability analysis of fuzzy control systems. Adaptive fuzzy controllers: Self-tuning and Self-organizing fuzzy controllers. Fuzzy Rule generation/reduction by clustering techniques. Overview of Type-2 fuzzy systems: Type-2 fuzzy sets, Type-reducer, Interval Type-2 fuzzy controllers.	
Unit III	**Neural Networks and Neuro fuzzy Systems**; **12hrs : CO3** Concept of Artificial Neural Networks and its basic mathematical model, Supervised and unsupervised neural networks Feed-forward Multilayer Perceptron. Self-organizing network and Recurrent network. Neural Network based controller, Learning and Adaptation; Training neural networks and fuzzy systems with least squares and gradient methods; Adaptive hybrid neuro-fuzzy control systems.	
Unit IV	**Nature inspired Optimization**; **6hrs : CO4** Basic concept of Genetic algorithm and its algorithmic steps, Solution of typical control problems using genetic algorithm. Concept on some other intelligent optimization techniques and their applications for optimal tuning of controller parameters and model parameters.	
Text Books	1. 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. 2. Intelligent Control: Aspects of Fuzzy Logic and Neural Nets, C.J. Harris, C.G. Moore& M. Brown, World Scientific , 1993. 3. An Introduction to Fuzzy Control, D. Driankov, H. Hellendroorn, M. Rainfrank, Springer-Verlag, Berlin Heidelberg, 1993.	
Reference Books	1. Fuzzy Logic: with Engineering Applications, T. J. Ross, Wiley, 2007. 2. Fuzzy Sets and Fuzzy Logic – Theory and Applications, George J. Klir, Yuan Bo; Prentice-Hall of India Pvt. Ltd., 2001. **3.** Simon Haykins, Neural Networks: A comprehensive Foundation, Pearson Edition, 2003. **4.** Genetic Algorithms in Search, Optimization, and Machine Learning, David E Goldberg, Addison Wesley, 1989.	
Mode of	Written CT-I & II	

Evaluation	Final-Written Term End Examination
Course delivery format	Black board teaching and PPT presentation
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 /414A : Intelligent Control 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	**1**	**3**												**1**	
	CO 2	**1**	**3**	**2**											**1**	
	CO 3	**1**	**3**	**2**		**1**									**2**	
	CO 4	**1**	**3**	**2**		**1**									**2**	

Course code: IEE/PE/B/T/414B	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.	
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, ion implantation. Outlines of Bipolar, MOS, CMOS and GaAs VLSI 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 of symmetric inverter, power dissipation issues, inverter capacitances, transmission gates and perfect signal steering, capacitance loads driven by transmission gates, NAND and NOR logic gates, stick diagrams, comparison of performances, derivation of combinational networks from canonic forms, AND-OR INVERT gate, complex gates, Sutton's method of network synthesis, combinational networks using Shannon's expansion theorem, MOS inverters driven by pass transistors two-input and two-variable universal logic modules, sequential MOS logic circuits, pre-charge and evaluation phases, pseudo-NMOS, Domino and NORA circuits, λ- based design rules. ROM, Multiplexer, PLA, PAL, CPLD and FPGA based implementation of VLSI, Verilog Programming	
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).	
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 /414B:VLSI Design	**CO1**	3	1												1	
	CO2	3	2												1	
	CO3	1	2	3											1	
	CO4	1	2	3											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)**	
List of Experiments:	1. Evaluation of Parameters of Piecewise Linear Model of Rectifier Diodes 2. Study of Reverse Recovery in Rectifier Diodes 3. Study of Switching Performance of a Darlington Transistor 4. Study of a Single-Phase, Half-controlled Rectifier Circuit 5. Study of an AC side controlled battery charger 6. Study of a buck converter 7. 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		PO1	PO2	PO3	PO4	PO5								PSO1	PSO2	PS03
	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 AND REMOTE CONTROL LABORATORY**	**L T P C** **0 0 4 2**
Course Prerequisites	**IEE/PC/B/T/316**	
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)	
List of Experiments:	1. Study of the characteristics of AM and FM modulators and demodulators. 2. Study of (1) pulse amplitude (2) pulse width and (3) pulse position modulation-demodulation Systems. 3. Study of pulse code modulation-demodulation systems. 4. Study of delta/adaptive delta modulation-demodulation systems. 5. Study of the characteristics of (1)ASK, (2) FSK and (3) PSK (BPSK and QPSK) Systems. 6. Study of a time division multiplexing system. 7. Study of the performance of a phase locked loop as a detector. 8. Study 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 AND REMOTE 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	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**	**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:	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		

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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/PS/B/S/413: PROJECT	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	
Unit II	**Basics of Azimuthal measurements: 8hrs : CO2** Basic parameters and their Azimuthal Measurements, unit and standard, ground based calibration and on-board calibration:	
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**	
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 Case study: **some observatory based solar data 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	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/PE/B/T /421A : Instrument ation for Astronomy and 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/421B	**Data Analysis for Instrumentation System**	**L T P C** **3 0 0 3**
Course Prerequisites	**BS/MTH/T111, BS/MTH/T122, FET/BS/B/Math/T/211, IEE/PE/B/T/41B**	
Objectives:	The course aims to provide adequate knowledge about • nature of the measured data. • different feature extraction and selection techniques. • various data preprocessing techniques. • different types of modelling and analysis techniques.	
Course Outcome:	On completion of the course, the students will be able to CO1:.Describe the nature of the measured data.(K2, A1). CO2: Describe and discuss the different feature extraction techniques (K2, A3-differentiate). CO3: Describe and apply the various data preprocessing techniques. (K3, A1). CO4: Describe and apply the different types of modeling and analysis techniques. (K3, A1).	
Unit I	**Data presentation: CO1:15 hrs** Methods of collection of primary data. Review of discrete and continuous variables, frequency distributions, cumulative frequency distribution, tabulation of data, mean of grouped data, median, mode, variance and standard deviation, skewness and kurtosis.	
Unit II	**Feature extraction and selection: CO2:10 hrs** Types of features, feature extraction and selection techniques.	
Unit III	**Data preprocessing: CO3:10 hrs :** Need for data preprocessing, Data handling and cleaning techniques, Data reduction techniques.	
Unit IV	**Modelling and analysis techniques: CO4: 25 hrs** Concept of different data modelling and analysis techniques, different data clustering and classification techniques, Linear and nonlinear regression analysis, performance measure techniques. Data analysis tools: Python, R, MATLAB.	
Text Books	1) Statistical Pattern Recognition by A. Webb, John Wiley & Sons, Ltd., England (2002). 2) Pattern Classification by Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons, 2012	
Reference Books	1) Feature Extraction: Foundations and Applications by Isabelle Guyon, Steve Gunn, MasoudNikravesh, Lofti A. Zadeh, Springer, 2008	
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 instrument manufacturer and maintenance sites, providing additional learning materials from research papers	
Other learning activities	Class 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/PE/B/ T/421B: Data Analysis for Instrumentation System	CO 1	3	2	1												
	CO 2	1	3	2												
	CO 3		3	2										1		
	CO 4		3	2										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: Understand the use of analytical instruments for smell and taste parameter measurements (K2, A2-study) CO3: Study different analysis techniques for handling sensor responses (K4,A2) CO4: Classify different types of sensors and instrument for smell and taste identification (K2, K4) CO5: Apply electronic sensing systems for real time applications (K3, A3-adapt)	
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, Olfactometry –Static and dynamic, Environmental chambers. Introduction to Electronic taste sensing system, Basic tastes	
Unit II	**Instruments for chemical sensing: 6hrs: CO1,CO2** Gas Chromatography, Olfactometry. HPLC- Taste attributes, Electronic nose, Electronic Tongue	
Unit III	**Sample handling and delivery system: 8hrs :CO3** Physics of evaporation, Sample flow system, Headspace sampling, Diffusion method, Permeation method, electrochemical sensing methods,	
Unit IV	**Sensors for olfaction and Taste sensing:10hrs :CO4** Survey and classification of chemosensors, Chemoresistors, MOS, Organic Conducting Polymers, Chemocapacitors, QCM, SAW, Optical odour sensors.	
Unit V	**Signal conditioning, pre-processing and analysis techniques: 8hrs :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	
Unit VI	**Introduction to Combined sensing systems: 8hrs: CO5** Data level fusion, Feature level fusion, Decision level fusion, Fusion models	
Text Books	1) Process Dynamics & Control by D. E. Seborg, T. F. Edgar & D. A. Mellichamp, 2nd eds., John Wiley & Sons. 2) Sensors and Sensory Systems for an Electronic Nose: J.W.Gardner	
Reference Books	1) Toko, Kiyoshi. Biomimetic sensor technology. Cambridge University Press, 2000 2) 3) 4)	
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 /422A: 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/PE/B/T/422B	**Industrial IoT**	**L T P C** **3 0 0 3**
Course Prerequisites		
Objectives:		
Course Outcome:	On completion of the course, the students will be able to CO1: Understand the concept of IIOT and Industry 4.0. CO2: Realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks. CO3: Ability to identify, formulate and solve engineering problems by using Industrial IoT. CO4: Ability to implement real field problem by gained knowledge of Industrial applications with IoT capability.	
Unit I	**Introduction to Industrial IoT (IIoT) Systems: 8 hrs** The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories.	
Unit II	**Basic of IIoT systems: 12 hrs** An Overview of Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Concepts of MQTT, CoAP, REST Api and gRPC, Different Communication protocols :(RFID, IEEE 802.15.4, Zigbee, 6LoWPAN, Bluetooth), LoRa, Machine-to-Machine (M2M) Communications	
Unit III	**IIoT Data Monitoring & Control: 10 hrs** IoT Gate way, IoT Edge Systems, IIoT cloud platforms like predix, thingworks, azure etc., Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology.	
Unit IV	**Industrial IoT- Applications: 10 hrs** In Smart cities, Industrial Automation, Autonomous Vehicles, Predictive Maintenance, Smart agriculture, Aerospace etc. Case studies of IIoT in Healthcare, Power Plants and Inventory Management & Quality Control.	
Text Books	1. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications 2. Bernd Scholz-Reiter, Florian 2. Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer	
Reference Books	1. Hakima Chaouchi, “ The Internet of Things Connecting Objects to the Web” ISBN : 978-1- 84821-140-7, Willy Publications. 2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications 3. Inside the Internet of Things (IoT), Deloitte University Press. 4. Internet of Things- From Research and Innovation to Market Deployment; By Ovidiu & Peter; River Publishers Series 5. Five thoughts from the Father of the Internet of Things; by By Phil Wainewright - Kevin Ashton 6. How Protocol Conversion Addresses IIoT Challenges: White Paper By RedLion.	
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	

Course code: IEE/HS/B/Prod/T/423	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. 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.	
Unit III	**Maintenance Management and Quality Control: 10 L** Maintenance management, reliability, replacement theory. Introduction to quality control, statistical quality control	
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	1) 2)	
Reference Books	1) 2) 3) 4)	
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)

IEE/HS/B/Prod/T/423: Industrial Management		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
	CO1		2				1		2	2	1	3				**1**
	CO2			3		2	1			2						**1**
	CO3		3				2		2			1				
	CO4			3		2	1			2						**1**
	CO5		3				2		2			1				

Course code: IEE/PC/B/S/421	**PROJECT**	**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:	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**
IEE/PC/B/S/421: PROJECT	**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**