Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination

Semester V (w.e.f. session 2020-2021)

S.No.	Course No.	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	EC-301	Electromagnetic Waves	3:0:0	3	3	75	25	0	100	3
2	EC-303L	Electromagnetic Waves Lab	0:0:2	2	1	-	40	60	100	3
3	EC-305	Computer Organization & Architecture	3:0:0	3	3	75	25	0	100	3
4	EC-307	Information Theory and Coding	3:0:0	3	3	75	25	0	100	3
5	EC-309	Digital Signal Processing	3:0:0	3	3	75	25	0	100	3
6	EC-311L	Digital Signal Processing Lab	0:0:2	2	1	0	40	60	100	3
7	ECP*	Program Elective-I	3:0:0	3	3	75	25	0	100	3
8	ECO*	Open Elective-I	3:0:0	3	3	75	25	0	100	3
9	**EC-313	Industrial Training-II	2:0:0	2	-	-	*100	-	*100	3
10	***MC-903	Essence of Indian Traditional Knowledge	3:0:0	3	-	100	-	0	100	3
		Total		**27**	**20**	**550**	**230**	**120**	**900**	

*** The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.**

**EC-313 is a mandatory credit-less course in which the students will be evaluated for the industrial training undergone after 4th semester and students will be required to get passing marks to qualify.

***MC-903 is a mandatory credit-less course in which the students will be required to get passing marks in the major test.

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LIST OF OPEN ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
V	ECO-1	Computer Networks
	ECO-2	Mechatronics
	ECO-3	Electronic Measurement and Instruments
	ECO-4	Renewable Energy Resources
MOOC1		

LIST OF PROGRAM ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
V	ECP-1	Probability Theory & Stochastic Processes
	ECP-2	Speech and Audio Processing
	ECP-3	Introduction to MEMS
	ECP-4	Power Electronics
	ECP-5	VLSI Technology

EC-301	Electromagnetic Waves							
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test		Total	Time
3	0	0	3	75	25		100	3 Hrs.
Purpose	*To familiarize the students with the concepts of Electric field, Magnetic Field and relation between them so that students can develop understanding about the generation and propagation of electromagnetic waves.*							
CO1	*Students will be able to understand and apply the basic laws of Electrostatics for the generation and propagation of electric field in different media.*							
CO2	*Students will be able to understand and apply the basic laws of Magnetostatics for the generation and propagation of magnetic field in different media.*							
CO3	*Students will be able to understand and develop the relations between Electric field and Magnetic field.*							
CO4	*Students will be able to understand and analyze the propagation of wave in different media.*							

Unit-I

Electrostatic: Review of coordinate system and vectors: Cartesian, Cylindrical and Spherical coordinate systems. Review of vectors: Gradient, curl, and Divergence of vector. Review of integral calculus: Line integral, Surface integral and Volume integral. Coulomb's law. Electric Field Intensity, Electric Potential, Field of a Line Charge, Field of a Sheet of Charge, Electric Flux, Electric Flux Density, Gauss's Law and its applications, Boundary conditions for Electric Field. Method of Images, Poisson's and Laplace's Equations, Uniqueness Theorem.

Unit-II

Magnetostatics: Differential Current Element, Biot - Savart Law. Magnetic field of a linear conductor of infinite length. Magnetic field of a circular current carrying loop. Magnetic Vector potentials, Magnetic Circuit, Force on a moving charge in magnetic field, Force on a Current Carrying Conductor in Magnetic Field, Torque on a closed current carrying loop in magnetic field. Magnetic flux and Magnetic flux density. Ampere's Circuit law, Faraday's Law, Boundary Conditions for Magnetic field, Maxwell's Equations for Free space, Good Conductors & Lossy Dielectric for Static & Sinusoidal Time Variations Fields, Retarded potentials.

Unit-III

Uniform Plane Wave: Plane Waves & its properties, Uniform Plane waves, Wave Equation for Free Space and Conducting Medium, Propagation of Plane Waves in Lossy Dielectrics, Good Dielectrics & Good Conductors. Skin effect and Skin depth for different medium. The Poynting's Vector and Poynting theorem.

Unit-IV

Transmission Lines and Waveguides: Representation of transmission line. Reflection in Transmission Line. The Transmission Line Equations, Graphical methods for solving transmission line. Rectangular Waveguides: TE, TM, TEM waves in rectangular wave guide, Calculation of field in rectangular waveguide foe TE and TM mode. Cut-off & Guided frequency of waveguide.

REFERENCES:

1 Electromagnetic Waves and Radiating Systems, E.C. Jordan & K.G. Balmain, PHI.
2 Field and Waves Electromagnetics, David K. Chang, Addison Wesley.
3 Engineering Electromagnetics, W H Hayt JR., Tata McGraw Hill.
4. Principles of Electromagnetics, Matthew N. O. Sadiku and S. V. Kulkarni. Oxford.

EC-305	Computer Organization and Architecture							
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Practical	Total	Time
3	-	-	3	75	25	-	100	3 Hrs.
Course Outcomes At the end of this course students will demonstrate the ability to								
CO1	*To understand the concept of basics of computer hardware & software*							
CO2	*To understand the concept of control design & processor design*							
CO3	*To familiarize with the concept of various memory systems.*							
CO4	*To familiarize with the concept of system organisation.*							

UNIT-I

Basic Structure of Computer Hardware and Software: Introduction to basic computer architecture, register transfer, bus and memory transfers, arithmetic, logic and shift micro operations. Central Processing Unit: Introduction, general register organization, stack organization, instruction formats, addressing modes, data transfer and manipulation, program control, RISC, Macros and Subroutines.

UNIT-II

Control Design: Micro programmed control, control memory, address sequencing, micro program example, design of control unit, Hardwired Control: design methods, Multiplier Control Unit, CPU Control unit.

Processor Design: Decimal arithmetic unit –BCD adder, BCD subtraction, decimal arithmetic operations, Forms of Parallel processing classification of Parallel structures, Array Processors, Structure of general purpose Multiprocessors.

UNIT-III

Memory Organization:

Memory hierarchy, device characteristics, auxillary memory, associative memory, cache memory, virtual memory, memory management, hardware multiprocessor architectures and their characteristics, interconnection structures, Random access memories: semiconductor RAMS, Serial-access Memories – Memory organization, Main Memory Allocation.

UNIT-IV

System Organization:

Pipeline and Vector Processing: Parallel processing, pipelining, arithmetic pipeline, instruction pipeline, RISC pipeline, vector processing, array processors, Input-output Organization: Peripheral devices, input-output interface, asynchronous data transfer, modes of transfer, priority interrupt, DMA,

Text Books:

1. Morris Mano, “Computer System Architecture”, PHI.
2. J.F. Heys, “Computer Organization and Architecture”, TMH.

Reference Books:

1. J. Hennessy and D. Patterson, Computer Architecture A Quantitative Approach, 3rd Ed, Morgan Kaufmann, 2002.

EC-307	INFORMATION THEORY AND CODING					
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Major Test	Minor Test	Total	Time
3	0	0	75	25	100	3 Hr.
Course Outcomes						
CO1	Acquire knowledge to understand the concept of information and entropy					
CO2	Ability to analyze and understand Shannon's theorem for coding					
CO3	Foster ability to identify basic errors Calculation of channel capacity					
CO4	To develop skills to apply coding techniques					

UNIT – I

Probability, random variables, Probability distribution functions and probability density functions, Expectation, moments, Random Processes, mean and Auto Correlation, Stationary and ergodicity, Information theory : the definition of information, the zero-memory information source, entropy for discrete ensembles; properties of entropy, Shannon's noiseless coding theorem; Encoding of discrete sources,

UNIT-II

Properties of codes: Introduction, types of codes: uniquely decodable codes, instantaneous codes, construction of an instantaneous code, Kraft inequality: statement and discussion and Proof, Markov sources; Shannon's noisy coding theorem and converse for discrete channels; Calculation of channel capacity and bounds for discrete channels; Application to continuous channels.

UNIT – III

Coding information sources: The average length of a code, Shannon's First Theorem, Finding binary compact codes- Huffman codes, Code efficiency and redundancy; Channels and mutual information: Information channels, Binary symmetric channels, Probability relations in a channel, A priori and A posteriori entropies, Mutual information, properties of mutual information, types of channels: Noiseless, deterministic, Cascaded channels, Channel capacity.

UNIT – IV

Channel Coding: Shannon second theorem for Noisy channels, Introduction to error control coding, Types of codes, Maximum Likelihood decoding, Linear block codes, Error detecting and correcting capabilities of a block code, Hamming code, cyclic code, convolutional arithmetic codes.

Text/Reference Books:

1. N. Abramson, Information and Coding, McGraw Hill, 1963.
2. M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987.
3. R.B. Ash, Information Theory, Prentice Hall, 1970.
4. Shu Lin and D.J. Costello Jr., Error Control Coding, Prentice Hall, 1983.

EC-309		Digital Signal Processing						
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Practical	Total	Time
3	-	-	3	75	25	-	100	3
Course Outcomes At the end of this course students will demonstrate the ability to								
CO1	Obtain Z-transformation of discrete time signals							
CO2	Obtain DFT and FFT of discrete time signals							
CO3	Implement structures for different discrete time systems							
CO4	Design of FIR and IIR digital filters for various applications							

Unit-I

Discrete Transforms: Z- transform and its properties, Inversion of Z-transform, One sided Z- transform and solution of differential equations. Analysis of LTI systems in Z-domain, causality, stability, schur-cohn stability test, relationship between Z-transform and Fourier transform.

Frequency Selective Filters: All pass filters, minimum-phase, maximum-phase and mixed- phase systems, Goertzel algorithm, Chirp Z-transform, applications of Z-Transform.

Unit-II

Frequency Domain Sampling and DFT: DTFT, DFT, properties, Linear filtering using DFT, Frequency analysis of signals using DFT, radix 2 and radix-4 FFT, computation of DFT of real sequences.

Implementation Structures of Discrete Time Systems: Direct form, cascade form, frequency sampling and lattice structures for FIR systems. Direct forms, transposed form, cascade form parallel form. Lattice and lattice ladder structures for IIR systems.

Unit-III

Design of FIR Filters: Characteristics of practical frequency selective filters, types of FIR filters, filter design specifications such as peak pass band ripple, minimum stop band attenuation etc., alternation theorem. Design of FIR filters using windowing method, frequency sampling method and Park-McClellan's method. Design of optimum equiripple FIR filters. Comparison of design methods for FIR filters. Effect of finite register length in FIR filter design.

Unit-IV

Design of IIR Filters: Design of IIR filters from analog filters, Design by approximation of derivatives, Impulse Invariance Method, Bilinear Transformation Method, Least Square Methods. Characteristics of Butterworth, Chebyshev and Elliptical analog filters, Frequency transformations, design of IIR filters in frequency domain.

Text/Reference Books:

1. J. G. Proakis and D.G. Manolakis, “Digital Signal Processing: Principles, Algorithms And Applications”, 4th ed. Prentice Hall.
2. A.V. Oppenheim and R. W. Schafer, “Discrete Time Signal Processing”, Prentice Hall, 1989.
3. S. K. Mitra, “Digital Signal Processing: A computer based approach”, McGraw Hill, 2011.
4. L. R. Rabiner and B. Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall, 1992.
5. J. R. Johnson, “Introduction to Digital Signal Processing”, Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, “Digital Signal Processing”, John Wiley & Sons, 1988.

ECP-1	Probability Theory &Stochastic Processes						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3Hr**
Purpose	**To familiarize the students with the basics of Probability Theory &Stochastic Processes**						
Course Outcomes							
CO1	**Develop an understanding to the basic concepts of Sets, Probabilities &Random Variables.**						
CO 2	**To understand various distribution functions &bounds.**						
CO 3	**To analyze and appreciate various Random Sequences and theorems.**						
CO 4	**To apply various Random Processes &Power Spectral Density to real life problems.**						

Unit-I

Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models. Discrete random variables, probability mass function, probability distribution function,example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions

Unit-II

Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds

Unit-III

Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.

Unit-IV

Random process. Stationary processes. Mean and covariance functions. Ergodicity, Transmission of random process through LTI. Power spectral density.

Text Books:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," ThirdEdition, Pearson Education

2. A. Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.

Reference Books:

1. K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International,
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, UBS Publishers
3. S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

ECP-2	SPEECH and AUDIO PROCESSING						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time(Hrs)**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3**
Course Objectives	To enlighten the students about the fundamentals of speech and audio processing.						
Course Outcomes At the end of this course the student should be able to							
CO1	Mathematically model the speech signal						
CO2	Analyze the quality and properties of speech signal.						
CO3	Modify and enhance the speech and audio signals.						
CO4	To understand various speed coding standards.						

Unit-I

Introduction- Speech production and modeling - Human Auditory System;General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid ; Requirements of speech codecs –quality, coding delays, robustness.

Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters,convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.

Unit-II

Linear Prediction of Speech- Basic concepts of linear prediction; LinearPrediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.

Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer,logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.

Unit-III

Scalar Quantization of LPC- Spectral distortion measures, Quantization based onreflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF.

Linear Prediction Coding- LPC model of speech production; Structures of LPCencoders and decoders; Voicing detection; Limitations of the LPC model.

Unit-IV

Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zerostate method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP.

Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards.

Text/Reference Books:

1. “Digital Speech” by A.M.Kondoz, Second Edition (Wiley Students Edition), 2004.
2. “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, W.C. Chu, WileyInter science, 2003.

ECP-3	Introduction to MEMS						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Major Test**	**Minor Test**	**Total**	**Time**	**Credit**
3	**0**	**0**	**75**	**25**	**100**	**3 Hr.**	**3**
Course Outcomes							
CO1	**Students will be using knowledge of mathematics, science, and engineering to understand various MEMS devices.**						
CO2	**Students be able to Appreciate the underlying working principles of MEMS and NEMS devices.**						
CO3	**Understanding basic principles of bulk micromachining and clean rooms practices**						
CO4	**Understand Design and model of MEM devices.**						

UNIT-I

Introduction: MEMS definition, classification of MEMS, Historical Background, Established applications of MEMS, modern MEMS applications, Miniaturization issues, Micro/Nano Sensors, Actuators and Systems overview, Multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators.

UNIT-II

Scaling laws in miniaturization - scaling advantages and issues, influence of scaling on material properties, scaling in mechanical systems, scaling in fluidic systems, scaling chemical and biological systems, scaling in heat conducting and heat convection.

UNIT-III

Basic MEMS fabrication methods: MEMS Fabrication Methods, Oxidation, Deposition Techniques, Photolithography, Materials for Micromachining, Substrates, additive Films and Materials, Bulk Micromachining, Wet Etching Dry Etching, Surface Micromachining, Fusion Bonding, High-Aspect-Ratio-Micromachining, LIGA, Laser Micromachining, Computer Aided Design, Assembly and System Integration, Multi-Chip Modules, Passivation and Encapsulation,

UNIT-IV

Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.

Text/Reference Book:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
2. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering (Vol. 8). CRC press, (2005).
3. S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
4. M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.

ECP-4	POWER ELECTRONICS						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Major Test**	**Minor Test**	**Total**	**Time**	**Credit**
3	**0**	**0**	**75**	**25**	**100**	**3 Hr.**	**3**
Course Outcomes							
CO1	**Acquire knowledge about Build and test circuits using power devices such as SCR**						
CO2	**Ability to analyze Analyze and design controlled rectifier, DC to DC converters, DC to AC inverters**						
CO3	**Foster ability to Learn how to analyze these inverters and some basic applications**						
CO4	**To develop skills to build, and Design SMPS.**						

UNIT-I

Characteristics of Semiconductor Power Devices: Thyristor, power MOSFET and IGBT : structure, Characteristics, operation, Brief introduction to power devices: TRIAC, MOS controlled thyristor (MCT), Thyristor Triggering circuit, Thyristor commutation circuit, Uses and design of snubber circuits for thyristor, power MOSFETs and IGBT. Fast recovery diodes and schottky diodes.

UNIT-II

Rectifiers types: Controlled and Uncontrolled Rectifiers: Single phase: Study of semi and full bridge converters for R, RL, RLE loads. Analysis of load voltage, load current and derivation of load form factor and ripple factor, Effect of source impedance on the performance of the controlled rectifiers, Analysis of three phase half wave controlled rectifiers with R load, Analysis of three phase half wave controlled rectifiers with R load.

UNIT-III

Choppers: Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, Control strategies for choppers, Detailed analysis of Type A chopper. Step up chopper. Inverters: Types of inverters, operating principle, Single phase half bridge inverter, Single phase full bridge inverter.

UNIT-IV

AC Voltage Controllers: Types of AC voltage controllers: symmetrical and asymmetrical controllers, Principle of phase control, ON-OFF control, Single phase ac voltage controller with R load. Cycloconverters: Principle of cycloconverter operation, step up and step down cycloconverters, Output voltage equation for a cycloconverter, Applications: Switching Power Supplies, SMPS, UPS.

Text /Reference Books:

1. Muhammad H. Rashid, “Power electronics” Prentice Hall of India.
2. Ned Mohan, Robbins, “Power electronics”, edition III, John Wiley and sons.
3. P.C. Sen., “Modern Power Electronics”, edition II, Chand& Co.
4. V.R.Moorthi, “Power Electronics”, Oxford University Press.
5. Cyril W., Lander,” Power Electronics”, edition III, McGraw Hill.

ECP-5	VLSI Technology						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Major Test**	**Minor Test**	**Total**	**Time**	**Credit**
3	**0**	**0**	**75**	**25**	**100**	**3 Hr.**	**3**
Course Outcomes							
CO1	**Students will be able estimate oxide thickness, growth rate, etch rate, deposition rate, and perform pattern etching etc. using knowledge of mathematics, science, engineering and practices.**						
CO2	**Students can design and conduct experiments such as oxidation, metallization and analyze growth / deposition rate, thickness etc.**						
CO3	**Shall be able to understand system, design such as CVD reactor, PVD chamber etc.**						
CO4	**Understanding of fabrication sequence of CMOS and NMOS , PMOS Integrated circuits.**						

UNIT-I

Crystal growth: monolithic and hybrid ICs, crystal growth, Czochralski technique of crystal growth, wafer preparation and specifications, defects, measurements of parameters of crystals, Fabrication steps, Oxidation: Theory of growth of Silicon dioxide layer, oxidation kinetics, Dry, wet and high pressure oxidation, plasma oxidation, properties of oxidation, defects induced due to oxidation.

UNIT -II

Epitaxial process: Epitaxy and its concept, Growth kinetics of epitaxial growth, Low temperature epitaxy, growth chemistry of Si epitaxial layer, apparatus for epitaxial layer, MBE system Diffusion process: Diffusion models of solid, Fick's theory of diffusion, Solution of Fick`s law, diffusion parameters measurements, Ion implantation: Scattering phenomenon, range theory, channeling, implantation damage, ion implantation systems, Annealing.

UNIT-III

Lithography: Optical and non-optical lithography, electron, X-ray and ion-beam lithography, contact/proximity and projection printers, alignment. Photoresist and Etching: Types of photoresists, polymer and materials, Etching- Dry & Wet etching, basic regimes of plasma etching, reactive ion etching and its damages, lift-off, and sputter etching.

UNIT-IV

Metallization: Applications and choices, physical vapor deposition, patterning, VLSI process fabrication steps: PMOS, NMOS and CMOS IC technology, Packaging : Package types, packaging design consideration, VLSI assembly technologies. Yield and reliability in VLSI.

SUGGESTED BOOKS:

1. S.M. SZE, VLSI Technology , McGraw Hill. 2009, 2nd Edition
2. S. K. Gandhi, VLSI Fabrication Principles, Wiley, 2nd edition
3. S.A. Campbell, The Science and Engineering of Microelectronic Fabrication ,Oxford 2008,2nd edition
4. Sedra & Smith, Microelectronic Circuits 2004, Oxford, 5th edition
5. J.D. Plummer, Silicon VLSI Technology: Fundamentals, Practice, and Modeling, Pearson.

ECO1		Computer Networks						
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Practical	Total	Time
3	-	-	3	75	25	-	100	3 Hrs
Purpose	To familiarize the students with the concepts of basic computer networks used in communication. Also familiarize the students with the various layers of OSI and TCP/IP model.							
	Course Outcomes							
CO1	To understand the concept of basics of computer networks and physical layer& media.							
CO2	To understand the concept and processes of data link layer and medium access sublayer.							
CO3	To familiarize with the concept and design issues of network, transport & session layer and presentation layer.							
CO4	To familiarize with the concept and protocols of application layer.							

Unit – I

Introduction: Introduction to Computer Networks, Protocols and standards, Network Models: The OSI Model, TCP/IP protocol suite, Introduction to addressing.

Physical Layer and Media: Guided &Unguided media,Circuit Switching and Packet Switching, The TelephoneSystem, ATM.

Unit -II

The Data Link Layer: Data Link Layer Design issues,Data link control: Framing, Flow & Error control, Noiseless channels, Noisy channels, HDLC, Point to Point protocols.

The Medium Access Sublayer: Aloha Protocols, LAN Protocols: wired LAN's, Wireless LAN.

Unit -III

Network Layer: Forwarding, Flow Control, Error Control, Multicast routing, IPv4 addresses, IPv6 addresses, internetworking, SNMP, ARP

Transport & Session Layer, Presentation Layer: Flow Control and Congestion Control at the Transport Layer,Transmission Control Protocol – Basic Features, TCP Congestion Control, cryptography

Unit-IV

Application Layer: Design issues, file transfer, access and management, electronic mail, WWW & HTTP

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Text Books:

1. Forouzan B.A, Data Communications and Networking, Tata-Mc-Graw Hill.
2. Tanenbaum A.S, Computer Networks, PHI.

Reference Books:

1. Stallings W, Data and Computer Communications, PHI.
2. Leon –Garcia, Computer Networks, Mc Graw Hill

ECO-2	MECHATRONICS						
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Total	Time(Hrs)
3	-	-	3	75	25	100	3

Course Outcomes

The Objective of this course is to make the students aware about Mechanical and Electronic Instruments together for different applications. This course will help students to build the fundamental concepts of inter disciplinary problems. **At the end of this course the student should be able**

CO1	To understand Mechatronics System and its applications.
CO2	To understand the operations of different Sensors and Transducers and their applications.
CO3	To understand the Electrical and Mechanical Actuation Systems operations and their uses.
CO4	To understand the basic structure of PLC and its applications and designing examples of Mechatronics Systems.

UNIT-I

INTRODUCTION TO MECHATRONICS: Definition, Evolution, Scope, Mechatronics Design Elements, Examples, and Applications; Measurement Systems; Control Systems: Open and Close Loop Systems, Block Diagram of Feedback Control System.

UNIT-II

TRANSDUCERS AND SENSORS: Transduction Principle, Classification of Transducers, Selection Parameters, Resistive, Inductive, Capacitive, Piezoelectric, Photoelectric, Measurement of Flow and Level; Sensors: LVDT, LMDT, Proximity, Force, Pressure, Pneumatic, Light, Touch and Tactile, Ultrasonic and Voice Recognition etc.

UNIT-III

ACTUATORS: Actuator Types and Application Areas, Electromechanical Actuators, Electrical Actuators : Servo and Stepper Motors; Pneumatic and Hydraulic Actuators, Piezoelectric Actuators, Magnetostrictive actuators, Memory-metal Actuators, Ion-exchange Polymer-metal Composite; Mechanical Actuators: Mechanism, Kinematics Chains, Bearings, Belt Drives, Chains and Chain Drives, Pulleys, Cams and Gears.

UNIT-IV

PLC AND MECHATRONIC SYSTEM DESIGN: Microprocessors, Microcontrollers; PLC**:** Introduction, Basic Structure, Input/Output Processing, Programming, Mnemonics, Timers, Internal Relays and Counters, Data Handling, Analog Input/Output, Selection of a PLC, Advantages and Uses; Design of Mechatronic Systems: Mechatronics design elements, Embedded system, MEMS, Robotics; Description of Designing a Mechatronic System: Automatic Camera, Washing Machine and List of some other Mechatronic Systems.

Text Books:

1. *R. K. Rajput, "A Textbook of Mechatronics", S. Chand & Company Pvt. Ltd, 2015.*
2. *Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", Tata McGraw-Hill publishing company Ltd, 2003.*
3. *M.D.Singh & J.G. Joshi, " Mechatronics" , PHI Learning Private Limited, 2015.*

Reference Books:

1 *Devdas Shetty & Richard A.Kolk, "Mechatronics System Design", PWS Publishing Company (Thomson Learning Inc.).*

2 *William Bolton, "Mechatronics Electronics Control systems in Mechanical and Electrical Engineering", Prentice Hall.*

ECO- 3	Electronic Measurement and Instruments						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3 Hr.**
Purpose	**To familiarize the students with the concepts of Electronics Measurements like measurement of voltage, current & resistance etc.**						
Course Outcomes							
CO1	**Students will learn the techniques of measurement of resistance using different bridges**						
CO2	**AC Bridges & Voltage Indicating & Recording Devices will be introduced to the students**						
CO3	**Students will be able to recognize the functioning of different Analog & Digital Instruments**						
CO4	**Transducers & Data Acquisition Systems will be introduced to the students**						

Unit-I

Measurement and Error: Functional elements and generalized configuration of a measuring Instrument, Characteristics of instruments, errors in measurements and their statistical analysis.

Measurement of Resistance: Wheat stone bridge, Carey-Foster Bridge, Kelvin double bridge, Measurement of Insulation resistance.

Unit-II

Bridges: Maxwell Inductance bridge. Maxwell Inductance Capacitance Bridge, Anderson's Bridge, Hay's Bridge, De-Sauty's Bridge, Schering's bridge and Wein's bridge.

Voltage Indicating and Recording Devices: Analog voltmeters and Potentiometers, Self balancing potentiometer and X-Y recorders, Galvanometers - Oscillographs, Cathode - Ray Oscilloscopes, Magnetic Tape Recorders.

Unit-III

Electronic Instruments: Wave analyzer, Distortion meter: Q-meter. Measurement of Op-Amp parameters.

Digital Instruments: Digital Indicating Instruments, Comparison with analog type, digital display methods, digital methods of time and frequency measurements, digital voltmeters.

Unit-IV

Transducers: Classification of Transducers, Strain Gauge, Displacement Transducers - Capacitive Transducers, LVDT, Piezo-electric Transducers, Temperature Transducers – resistance thermometer, Thermocouples and Thermistors, Liquid level measurement Low pressure (vacuum) measurement.

Data Acquisition Systems: A to D and D to A converters, Analog and Digital Data Acquisition Systems, Multiplexing, Spatial Encoders, Telemetry.

Text Book:

1. A Course in Electrical and Electronics Measurements and Instrumentation: A.K. Sawhney; Dhanpat Rai & Sons.

Reference Books:

1. Electronics Instrumentation and Measurement Techniques: Cooper W.D & Helfrick A.D.; PHI Doeblin E.O., Measurement Systems: Application & Design, Mc Graw Hill.

ECO-4	Renewable Energy Resources						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3 Hour**
Course Outcomes							
CO 1	**To understand the energy demand of world, nation and available resources to fulfill the demand**						
CO 2	**To know about the conventional energy resources and their effective utilization**						
CO 3	**To acquire the knowledge of modern energy conversion technologies**						
CO 4	**To be able to understand and perform the various characterization techniques of fuels**						
CO5	**To be able to identify available nonconventional (renewable) energy resources and techniques to utilize them effectively.**						

Unit-I

Introduction: Energy demand of world and country and gap analysis, Fossil fuel based systems, Impact of fossil fuel based systems, Non conventional energy – seasonal variations and availability, Renewable energy– sources and features, Hybrid energy systems. Distributed energy systems and dispersed generation (DG).

Unit-II

Solar thermal systems: Solar radiation spectrum, Radiation measurement , Technologies, Applications, Heating, Cooling, Drying, Distillation, Power generation; Costing : Life cycle costing (LCC),Solar thermal system

Solar Photovoltaic systems ,Operating principle, Photovoltaic cell concepts ,Cell, module, array, Series and parallel connections, Maximum power point tracking, Applications ,Battery charging, Pumping , Lighting,Peltier cooling , Costing: Life cycle costing ,Solar PV system

Unit-III

Microhydel: Operating principle, Components of a microhydel power plant, Types and characteristics of turbines, Selection and modification, Load balancing, Costing: Life cycle costing –Microhydel Wind ; Wind patterns and wind data, Site selection, Types of wind mills , Characteristics of wind generators, Load matching, Life cycle costing - Wind system LCC.

Unit-IV

Biomass: Learning objectives, Operating principle, Combustion and fermentation, Anaerobic digester, Wood gassifier, Pyrolysis, Applications, Bio gas, Wood stoves, Bio diesel, Combustion engine, Life cycle costing - Biomass system LCC

Hybrid Systems, Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles

Suggested Books:

1. Ashok V Desai, Non-Conventional Energy, Wiley Eastern Ltd, New Delhi, 2003
2. Mittal K M, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, New Delhi,2003
3. Ramesh R & Kumar K U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 2004
4. Wakil MM, Power Plant Technology, Mc Graw Hill Book Co, New Delhi, 2004.

EC-303L	Electromagnetic Waves Lab						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
		3	1.5	40	60	100	3 Hour
Purpose	To give the students an idea about the study and analysis of components used in Microwave Engineering						
Course Outcomes							
CO1	*Students will learn the steps to analyze electric field behavior.*						
CO2	*Students will be able to characterize standing wave ration and reflection Coefficient.*						
CO3	*Students will learn the steps to analyze types of waveguide.*						
CO4	*Students will be able to find the unknown impedances in a transmission line.*						

List of Experiments:

1. Measurement of Electric Field between Parallel Conductors.
2. To Determine Electric Field Pattern between Two Circular Electrodes.
3. Experimentally determine the standing wave ration and reflection Coefficient in a transmission line.
4. Measurement of Dielectric Constant.
5. Design & Characterization of Rectangular Waveguide for dominant mode using HFSS.
6. Experimentally determine the frequency & Wavelength in a rectangular waveguide working in TE_{10} mode using microwave bench.
7. Design & Characterization of Circular Waveguide using HFSS.
8. Design & Characterization of Microstrip Line using HFSS.
9. To measure unknown impedance with Smith Chart.
10. Desgin & Characterization of Microstrip line using simulation software.

EC-311L	Digital Signal Processing Lab							
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Practical	Total	Time
-	-	2	1	-	40	60	100	3
Course Outcomes At the end of this course students will demonstrate the ability to								
CO1	Plot different discrete time signals							
CO2	Verify the aliasing effects							
CO3	Design digital FIR filters for various applications							
CO4	Design digital IIR filters for various applications							

List of Experiments

1. Write a program to plot the following functions: a) impulse function b) unit step c) unit ramp d) exponential and e) sinusoidal
2. Write a program to plot real part, imaginary part, magnitude and phase spectra of an exponential function.
3. Study the aliasing effect by using a sinusoidal signal. Show the plots of' continuous time signal, sampled signal and reconstructed signals by using subplot.
4. Write a program to compute and plot the convolution of two signals.
5. Define a function to compute the Z-transform of a finite length signal.
6. Verify the properties of Discrete Fourier Transform (DFT).
7. Study of different window functions available for design of FIR filters.
8. Design of FIR filters by using windowing method.
9. Design of equiripple FIR filter.
10. Study of magnitude and phase response of Butterworth, Chebyshev and Elliptic filters.
11. Design of IIR filters by using different analog filter approximation method.

	B. Tech. (5th Semester) Electronics and Communication Engineering							
MC-903	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time (Hrs.)**
3	**0**	**0**	**--**	**100**	**--**	**--**	**100**	**3**
Purpose	To impart basic principles of thought process, reasoning and inferencing.							
Course Outcomes								
CO 1	The students will be able to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.							

Course Contents

- Basic structure of Indian Knowledge System: अष्टादशविद्या -४वेद,४उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थापत्य आदि) ६वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) ४ उपाङ्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
- Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan
- Fritzof Capra, *Tao of Physics*
- Fritzof Capra, *The Wave of life*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
- P B Sharma (English translation), *Shodashang Hridayan*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination
Semester VI (w.e.f. session 2020-2021)

S. No.	Course No.	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	HM-901	Organizational Behavior	3:0:0	3	3	75	25	0	100	3
2	EC-302	Control System Engineering	3:0:0	3	3	75	25	0	100	3
3	EC-304L	Control System Engineering Lab	0:0:3	3	1.5	-	40	60	100	3
4	EC-306	Verilog HDL	3:0:0	3	3	75	25	0	100	3
5	EC-308L	Verilog HDL Lab	0:0:3	3	1.5	-	40	60	100	3
6	EC-310L	Mini Project/Electronic Design Workshop	0:0:4	4	2	-	40	60	100	3
7	ECP*	Program Elective-II	3:0:0	3	3	75	25	0	100	3
8	ECO*	Open Elective-II	3:0:0	3	3	75	25	0	100	3
		Total		**25**	**20**	**375**	**245**	**180**	**800**	

*** The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section. Note: All the students have to undergo 4 to 6 weeks Industrial Training after 6th semester which will be evaluated in 7th semester.**

Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination

LIST OF OPEN ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
VI	ECO-5	Data Structures
	ECO-6	Multimedia Communication
	ECO-7	Consumer Electronics
	ECO-8	Transducers and Their Applications

LIST OF PROGRAM ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
VI	ECP-6	Antennas and Propagation
	ECP-7	CMOS Design
	ECP-8	Bio-Medical Electronics
	ECP-9	Scientific Computing

EC-302	Control System Engineering (6th Semester)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3 Hours**
Purpose	The purpose of this course is to create awareness about the various types of control systems with the techniques to analyze them so that the learner is able to mathematically design and evaluate the conditions for which a control system can provide stable output with improved performance.						
CO1	Learner will be able to design and simplify the mathematical and graphical models of a control system through block diagram and signal flow graph method.						
CO2	Learner can evaluate the conditions for which a system can work under stable conditions in time domain.						
CO3	Learner will know about easier graphically methods to evaluate the conditions of stability in frequency domain.						
CO4	Learner will able to apply the compensation technique using state variable approach to covert an unstable system into a stable system under certain conditions.						

UNIT-I

Introduction: The Control system-Open loop & Closed loop, servomechanism, Stepper motor. Mathematical Models of Physical Systems: Differential equation of physical systems, Transfer Function, Block Diagram Algebra, Signal Flow-Graphs, Mason's Formula & its application. Feedback Characteristics of Control Systems: Feedback and Non-Feedback systems, Effects of Feedback on sensitivity (to parameter variations), Stability, Overall gain etc.

UNIT-II

Time Response Analysis: Standard test signals, Time response of first order and second order systems, Steady-State Errors and Error Constants, Design Specification of second-order- systems. Stability: The concept of stability, necessary conditions for stability, Hurwitz Stability Criterion, Routh Stability Criterion, Relative Stability Analysis. The Root Locus Technique: The Root Locus Concept, Construction /development of Root loci for various systems, Stability considerations. Proportional, Integral and Derivative Controllers.

UNIT-III

Frequency Response & Stability Analysis: Correlation between Time and Frequency response, Polar Plots, Nyquist plots, Bode Plots, Nyquist Stability criterion, Gain margin & Phase margin, relative stability using Nyquist Criterion, frequency response specifications.

UNIT-IV

Compensation of Control Systems: Necessity of Compensation, Phase Lag compensation, Phase Lead Compensation, Phase Lag Lead Compensation, Feedback Compensation. State Variable Analysis: Concept of State, State Variable and State Model, State Models for Linear Continuous Time Systems, Diagonalization, Solution of state equations, Concept of Controllability and Observability.

Text Book: *Control System Engg.: I. J. Nagrath & M.Gopal; New Age India.*

Reference Books:

1.Automatic Control Systems: B.C. Kuo; PHI.
2.Modern Control Engg: K. Ogata; PHI.
3.Control Systems: Principles & Designing : Madan Gopal; TMH.

EC-306	Verilog HDL						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time(Hrs)**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3**
Course Objectives	To familiarize the students with the conventions of the Verilog HDL programming, algorithmic levels of abstraction for modelling digital hardware systems, the concept of test-benches to create testing behavioral environments for simulation based verification.						
Course Outcomes At the end of this course the student should be able to							
CO1	To understand the constructs and conventions of the Verilog HDL programming.						
CO2	To understand the structural, register-transfer level (RTL), and algorithmic levels of abstraction for modelling digital hardware systems.						
CO3	To design and modelling of combinational and sequential digital systems						
CO4	To apply the concept of test-benches to create testing behavioral environments for simulation based verification.						

Unit- I

Introduction: Introduction, conventional approach to digital design, VLSI design, ASIC design flow, Role of HDL, Conventional Data flow, ASIC data flow, Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools, Test Benches.
Language constructs and conventions: Introduction, Keywords, Identifiers, White Space Characters,
Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators, System Tasks.

Unit-II

Gate level modelling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Additional Examples, Design of Flip-flops with Gate Primitives, Delays, Strengths and Contention Resolution, Net Types, Design of Basic Circuits.
Behavioralmodelling: Introduction, Operations and Assignments, Functional Bifurcation, Initial Construct, Always Construct, Examples, Assignments with Delays, Wait construct, Multiple Always Blocks, Designs at Behavioral Level, Blocking and Non-blocking Assignments, The case statement, Simulation Flow, if and ifelse constructs, assign-deassign construct, repeat construct, for loop, the disable construct, while loop, forever loop, parallel blocks, force-release construct, Event.

Unit-III

Modelling at data flow level: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Additional Examples.

Switch level modelling: Introduction, Basic Transistor Switches, CMOS Switch, Bi-directional Gates, Time Delays with Switch Primitives, Instantiations with Strengths and Delays, Strength Contention with Trireg Nets.

Unit-IV

Functions, tasks, and user defined primitives: Introduction, Function, Tasks, User- Defined Primitives (UDP), FSM Design (Moore and Mealy Machines).
System tasks, functions, and compiler directives: Introduction, Parameters, Path Delays, Module Parameters, System Tasks and Functions, File-Based Tasks and Functions, Compiler Directives, Hierarchical Access, General Observations.

Text Books:

1. T. R. Padmanabhan, B. Bala Tripura Sundari (2004), Design through Verilog HDL, Wiley & SonsEducation, IEEE Press, USA.
2. J. Bhaskar (2003), A Verilog Primier, 2nd edition, BS Publications, India.

Reference Books:

1. Samir Palnitkar (2013), Verilog HDL, Pearson India.
2. Stephen. Brown, ZvonkoVranesic (2005), Fundamentals of Logic Design with Verilog, Tata McGraw
Hill, India.
3. Charles H. Roth (2004), Digital Systems Design using VHDL, Jr. Thomson Publications, India.

EC-308L	Verilog HDL Lab							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Practical**	**Total**	**Time**
0	**0**	**3**	**1.5**	**0**	**40**	**60**	**100**	**3 Hour**
CO1	To describe, design, simulate, and synthesize circuits using the Verilog hardware							
CO2	To design and modelling of combinational and sequential digital system.							
CO3	To develop program codes for synthesis-friendly combinational and sequential logic.							
CO4	To understand the advanced features of Verilog HDL and be able to write optimized codes for complex systems.							

List of Experiments:

1. Write a Program to implement logic gates.
2. Write a Program to implement half-adder.
3. Write a Program to implement Full-adder.
4. Write a Program to implement 4 bit addition/subtraction.
5. Write a Program to implement a 3:8 decoder.
6. Write a Program to implement an 8:1 mulltiplexer.
7. Write a Program to implement an 1:8 demultiplexer.
8. Write a Program to implement 4 bit comparator.
9. Write a Program to implement Mod-10 up counter.
10. Write a Program to perform serial to parallel transfer of 4 bit binary number.
11. Write a program to perform parallel to serial transfer of 4 bit binary number
12. Write a program to implements 8 bit ALU containing 4 arithmetic & 4 logic operation.

EC-304L	Control System Engineering Lab						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
		3	1.5	40	60	100	3 Hour
Purpose	To make students capable to design solutions for Control System engineering problems and design system components or processes that meet the specified needs of modern automated engineering industries.						
Course Outcomes							
CO1	Students will be able to execute time response analysis of a second order control system using MATLAB						
CO2	Students will be able to design Lag, Lead, Lead-Lag compensators and verify experimental results using MATLAB.						
CO3	Analyze toque- speed characteristics of DC and AC servomotors.						
CO4	Analyze and interpret stability of the system through Root Locus, Bode plot and Nyquist plot.						

List of Experiments:

1. Using MATLAB obtain time response of a second order system in case of under damped, over damped and critically damped systems.

2. To design a passive RC lead compensating network for the given specifications and to obtain its frequency response.

3. To design a passive RC lag compensating network for the given specifications and to obtain its frequency response.

4. To obtain torque speed characteristics of AC servo motor.

5. To obtain torque speed characteristics of DC servo motor.

6. To determine frequency response of a second order system and evaluation of Frequency domain specifications.

7. To simulate a DC position control system and hence to find the step response using MATLAB.

8. Obtain the phase margin and gain margin for a given transfer function by drawing bode plots and verify the same using MATLAB.

9. To obtain Root locus of a given T. F. and hence finding breakaway point, intersection point on imaginary axis and to draw the Nyquist plot for the given transfer function using MATLAB.

10. To digitally simulate the time response characteristics of Linear SISO systems using state variable formulation.

11. Experiment to draw the frequency response of a given lead-lag compensating network.

ECP-6	Antennas & Propagation							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**		**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**		**100**	**3 Hrs.**
Purpose	*To familiarize the students with: Antennas used for various applications, performance parameters of antenna, methods of analysis of antenna, and different ways of propagating the signal.*							
CO1	*To Understand the structure and properties of various antennas.*							
CO2	*To understand the performance parameters of antenna.*							
CO3	*To design antenna of required specifications.*							
CO4	*To understand the different ways of signal propagation.*							

Unit-I

Fundamental concept: Physical concept of radiation, Retarded potential, Radiation pattern, near- and far-field regions. **Antenna Parameters:** Radiation Resistance, Gain, Directive Gain, Power Gain, Directivity, Efficiency, Beam width, Effective Height, Effective Aperture, Bandwidth and Antenna Temperature. **Radiation from Wires:** Radiation from Hertzian Dipole, Short Dipole, Monopole Antenna, Folded Dipole Antenna and Half Wave Dipole.

Unit-II

Antenna Arrays: Uniform Linear Arrays - Broadside Arrays, Endfire Arrays. Analysis of arrays of 2 Isotropic Sources - Different Cases, Analysis of arrays of N Isotropic Sources - Different Cases, Principle of Pattern Multiplication, Binomial Array, Chebyshev Array. **TV Transmission & Reception Antennas:** Turnstile Antennas, Yagi-Uda antennas. **Standard Antennas:** Loop Antenna (Rectangular & Circular), Helical Antenna, Biconical Antenna.

Unit-III

Aperture & Slot Antennas: Radiation from Rectangular Apertures, Uniform and Tapered Aperture, Horn antenna, Reflector Antenna , Cassegrain and Gregorian Feeding Structures, Rectangular Slot Antenna. **Broadband Antennas**: Huygens' Principle, The frequency independent concept: Rumsey's principle, Frequency Independent Planar Log Spiral Antenna, Frequency independent conical spiral antenna, Log periodic antenna, Lens Antenna.
Microstrip/Patch Antennas: Basic configurations of patch antennas: Rectangular, Circular. Different Feeding Techniques. Method to Analyze Patch antenna: Transmission Line Model.

Unit-IV

Propagation of Radio Waves: Introduction, Ground Wave Propagation, Space Wave Propagation and Sky Wave Propagation: Virtual Height, Critical Frequency, Maximum Usable Frequency (MUF) – Skip Distance, Fading, Multi Hop Propagation, Duct Propagation, Troposcatter Propagation, Flat Earth and Curved Earth Concept,.

REFERENCES:

1. J. D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
3. Antenna & Wave Propagation- K.D. Prasad, Satya Parkashan.
3. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
4. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House, 1980.
6. A.R.Harish, M.Sachidananda, Antenna and Wave Propagation, Oxford University Press.

ECP-7	CMOS Design					
Lecture	**Tutorial**	**Practical**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**75**	**25**	**100**	**3 Hr.**
		Course Outcomes				
CO1	Student will be able to analyze MOS transistor characteristics					
CO2	Student will be able to design CMOS invertor of specific characteristics					
CO3	Student will be able to design combinational CMOS circuit of given boolean equation					
CO4	Student will be able to design sequential CMOS circuit of given specification					

Unit- I

Introduction: Overview of VLSI Design Methodologies, VLSI Design flow, Design hierarchy, VLSI Design styles.
MOS Transistor: MOS structure, MOS system under external bias, structure and operation of MOSFET, C-V characteristics.

Unit- II

MOS Invertors: Introduction, resistive load invertor, invertor with n-type MOSFET load, CMOS invertor: circuit operation, noise margin, design of invertor, power and area consideration. .

Unit -III

Combinational MOS Logic: nMOS logic circuits with depletion nMOS load, CMOS logic circuits, complex logic circuits, CMOS pass gates

Unit-IV

Sequential MOS Logic circuits: Behaviour of bistable elemens, SR latch circuit, clocked latch and flip flop, CMOS D Latch and edge triggered flip flop

Text Books:
1. S. M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, MH, 2002.

Reference Books:
1. N. Weste, K. Eshraghian and M. J. S. Smith, Principles of CMOS VLSI Design : A Systems Perspective, Second Edition (Expanded), AW/Pearson, 2001.
2.J. P. Uyemura, CMOS Logic Circuit Design, Kluwer, 1999.

ECP-8		Biomedical Electronics						
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Practical	Total	Time
3	-	-	3	75	25	-	100	3
Course Outcomes At the end of this course students will demonstrate the ability to								
CO1	Understand and explain the concept of biomedical signals, electrodes and Instrumentation							
CO2	Understand and explain the physiological transducers and recording systems							
CO3	Understand and explain biomedical recorders and patient monitoring systems							
CO4	Understand and explain cardiac pacemakers, defibrillator and patient safety							

UNIT-I

Introduction: Role of technology in medicine, physiological systems of the body, sources of biomedical signals, basic medical instrumentation and their performance requirements, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, role of engineers in healthcare facilities.

Bioelectric Signals and Electrodes: Origin of bioelectric signals, recording electrodes, silver- silver chloride electrodes, electrodes for ECG, electrodes for EMG, electrical conductivity of electrode jellies and creams, microelectrodes.

UNIT-II

Physiological Transducers: Definition, classification and performance characteristics of transducers, displacement, position and motion transducers, pressure transducers, transducers for body temperature measurement, photoelectric transducers, optical fiber sensors, biosensors, smart sensors.

Recording System: Basic recording system, general considerations for signal conditioners, preamplifiers, sources of noise in low level measurements, biomedical signal analysis and processing techniques, the main amplifier and driver stage, writing systems.

UNIT-III

Biomedical Recorders: Electrocardiograph, vectorcardiograph (Vcg), phonocardiograph (Pcg), digital stethoscope, electroencephalograph (Eeg), electromyograph.

Patient Monitoring Systems: System concepts, cardiac monitor, bedside patient monitoring systems, central monitors, measurement of heart rate, measurement of temperature, measurement of respiration rate, catheterization laboratory instrumentation, ambulatory monitoring instruments.

UNIT-IV

Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker and defibrillator, external pacemakers, implantable pacemakers, pacing system analyzer, DC defibrillator, implantable defibrillators, types of defibrillators, defibrillator analyzer.

Patient Safety: Electric shock hazards, leakage currents, safety codes for electromedical equipment, electrical safety analyzer.

Text/Reference Books:

1. R S Khandpur: Handbook of biomedical instrumentation, 3rd ed., McGraw Hill Education.
2. Joseph D. Bronzino: The biomedical engineering handbook, 2nd ed., CRC Press.

ECP-9		Scientific Computing						
Lecture (Hrs.)	Tutorial (Hrs.)	Practical (Hrs.)	Credit	Major Test	Minor Test	Practical	Total	Time
3	-	-	3	75	25	-	100	3
Course Outcomes At the end of this course students will demonstrate the ability to								
CO1	To understand the concept of computational linear algebra and apply the matrix decompositions techniques to solve the problems of linear algebra							
CO2	To understand the concept of Scientific computing and will be able to find the solution of linear and non linear equations							
CO3	To learn the concept of Vector functions, partial derivatives, gradient and tangent planes							
CO4	To understand the various numerical techniques for solving differential equations and use MATLAB to visualize the solutions practically.							

Unit -I

Introduction to Computational Linear Algebra

Fundamental algorithms in computational linear algebra with relevance to all science concentrators. Basic linear algebra and matrix decompositions (Cholesky, LU, QR, etc.), round-off errors and numerical analysis of errors and convergence. Iterative methods and conjugate gradient techniques. Computation of eigenvalues and eigenvectors, and an introduction to least squares methods

Unit –II

Introduction to Scientific Computing

Numerical computations; Includes instruction for programming in MATLAB. Applications solution of linear equations (with vectors and matrices) and nonlinear equations (by bisection, iteration, and Newton's method),interpolation, and curve-fitting, difference equations, iterated maps, numerical differentiation and integration, and differential equations.

Unit –III

Vector Functions; Derivatives,tangent vector velocity,acceleration,arc length of space curve,curvature and normal vectors,functions of two or more variables,limits and continuity,partial derivatives,directional derivatives,gradient and tangent planes,second derivative ,maxima,minima,sable point

Unit -IV

Introduction to Numerical Solution of Differential Equations Fundamental numerical techniques for solving ordinary and partial differential equations. Overview of techniques for approximation and integration of functions Differential equations,First Order differential equations,variables separable form,solution of first order linear equation,second and higher order equations,solution of constant coefficient second order equation, Solution of two-point boundary value problems, introduction to methods for solving linear partial differential equations.

Text/Reference Books:

1. Calculus and Analytical Geometry (9^{th} Edition) Thomas and Finney Pearson Education
2. Calculus (5^{th} Edition) James Stewart
3. Advanced Engineering Mathematics (8^{th} Edition) Erwin Kreyszig John Willey and Sons
4. Linear Algebra (2^{nd} edition) Hoffman and Kunz Prentice Hall International
5. Linear Algebra Peter D.Lax
6. Differentials Equations with applications and Historical notes. Simmons G.F

ECO-5	Data Structures						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Major Test**	**Minor Test**	**Total**	**Time**	**Credit**
3	**-**	**-**	**75**	**25**	**100**	**3 Hr.**	**3**
		Course Outcomes					
CO1	Student will be able to determine the time complexity of various operations on arrays						
CO2	Student will be able to select appropriate data structure for given application						
CO3	Student will be able to create link list and apply various operations.						
CO4	Student will be able to evaluate the traversal of binary trees and represent graphs						

Unit- I

Introduction: Concept of Data Structures, Design of suitable algorithm, algorithm analysis.
Arrays: 1-D arrays: Traversal, Selection, Searching, Insertion, Deletion and Sorting. Multi-D arrays, representation of arrays in physical memory, application of arrays

Unit- II

Stacks and Queues: Stacks: Stack operations, Application of Stacks, Queues: operations, circular queue, priority queue, deque
Pointers: Introduction, pointer variable, pointers and arrays, array of pointers, pointers and structures

Unit -III

Linked Lists: Introduction, Operations: Creation, Traversal, Searching, Insertion and Deletion. Circular and Doubly linked list, linked stacks and queues.

Unit-IV

Trees: Basic terminology, binary trees, representation of binary trees: linear and linked, traversal of binary trees
Graphs: graph terminology, representation of graphs: array based, linked list based, set based.

Text Books:
1.Data Structures using C by A. K. Sharma , Pearson Publication
2.Theory & Problems of Data Structures by Jr. Symour Lipschetz, Schaum's outline by TMH.
Reference Books:
1.Data Structures using C by A. M. Tenenbaum, Langsam, Moshe J. Augentem, PHI Pub
2.Data Structures and program design in C by Robert Kruse, PHI Expert Data Structures with C by R.B. Patel

ECO-6	Multimedia Communication						
Lecture (Hrs.)	**Tutorial (Hrs.)**	**Practical (Hrs.)**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3 Hrs.**
PO	To familiarize the students with the concepts of basic multimedia communication systems and various compression algorithms of text, audio, image and video.						
Course Outcomes (CO)							
CO1	Students will understand the concept of multimedia communication system along with its applications and networks in detail.						
CO2	Students will be able to learn the concept of compression in detail. They will understand the techniques of text and image compression.						
CO3	In this outcome students will be well prepared of audio and video compression.						
CO4	Students will understand the concept internet, its applications and CBIR systems						

UNIT-I

Multimedia Communication: Introduction, Multimedia networks: Telephone networks, Data networks, Television Networks, ISDN, B-ISDN. Multimedia Applications: Interactive applications over the internet and Entertainment applications.

Digitization Principles, Representation of Text, Images, Audio and Video.

UNIT-II

Text Compression: Compression principles, Text Compression techniques: Static Huffman Coding, Dynamic Huffman Coding, Arithmetic Coding, Lempel Ziv and Lempel Ziv welsh coding.

Image Compression: Graphics interchange format, Tagged image file format, Joint Photographic Experts Group (JPEG).

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UNIT-III

Audio Compression: Differential Pulse Code Modulation, Adaptive Differential PCM, Adaptive Predictive coding, linear predictive coding and MPEG audio coders,

Video Compression: Video Compression principles, Frame types, Motion estimation and compensation, Implementation Schematics of I, P and B frames, H.261, H.263.

UNIT-IV

Multimedia Synchronization: Basic definitions and requirements Time stamping and Pack architecture.

Internet Applications: Domain name System, Electronic Mail, Internet Telephony, Content Based Image Retrieval Systems

Text Books:

1. Multimedia communications: Fred Halsall; Pearson Education Asia.

Reference Books:

1. Multimedia Systems" by Ralf Steinmetz and Klara Nahrstedt
2. Multimedia Systems, Standards, and Networks" by A. Puri and T. Chen

ECO-7	Consumer Electronics						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**75**	**25**	**100**	**3**
Course Outcomes							
CO1	To understand fundamentals of Monochrome and Colour TV systems.						
CO2	To understand television receivers and digital TV systems.						
CO3	To understand audio fundamentals and systems.						
CO4	To maintain various electronic home appliances.						

UNIT-I

Monochrome TV Systems and Colour TV Systems: Monochrome picture signal transmission and reception, scanning process, aspect ratio, persistence of vision and flicker, interlace scanning, picture resolution, Composite video signal, vestigial sideband transmission. Colour theory, Grassman's Law, hue, brightness, saturation, luminance and chrominance, Different types of TV camera tube, channel bandwidth.

UNIT-II

Television Receivers: Monochrome and colour picture tube, receiver controls, remote control, Television standards: PAL, SECAM, NTSC.

Digital TVs: working principle of HDTV, Principle and working of LCD and LED TV, Block diagram and working principle of OLED.

UNIT-III

Audio Fundamentals: Basic characteristics of sound signal: level and loudness, pitch, frequency response, fidelity and linearity, Reverberation, Microphone: working principle, characteristics, Types: carbon, condenser, crystal, electrostatic. Loudspeakers: working principle, Types: electrostatic, dynamic, permanent magnet.

UNIT-IV

FAX, Microwave Oven: types, single chip controllers, Washing Machine: wiring diagram, electronic controller for washing machine, types of washing machine, Air conditioner and Refrigerators: Components features, types and applications, Digital camera, ATM.

TEXT BOOKs:

- R.R. Gulati "Modern Television practices", New Age International Publication (P) Ltd. New Delhi Year 2011, latest edition.
- S.P. Bali., "Consumer Electronics", Pearson Education, 2010, latest edition.

REFERENCES:

- R Bali and S.P. Bali “Audio video systems : principle practices & troubleshooting”, Khanna Book Publishing Co. (P) Ltd., 2010Delhi , India, latest edition.
- R.G. Gupta “Audio video systems”, Tata Mc graw Hill, New Delhi, India 2010, latest edition.
- Jerry Whitaker & Blair Benson “Mastering Digital Television”, McGraw-Hill Professional, 2010 , latest edition.

ECO-8	Transducers & Its Applications						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3		**-**	**3**	**75**	**25**	**100**	**3**
Purpose	**Understanding the structural and functional principles of sensors and transducers used for various physical and nonelectric quantities and how to use them to measure these quantities.**						
Course Outcomes							
CO 1	**Explain the principles of operation of the sensor parameters and generators**						
CO 2	**Interpretation of the measurement results by using transducers.**						
CO 3	**Development of measurement schemes for different non electrical quantities**						
CO 4	**Assimilating knowledge about the implementation of sensors and transducers.**						

Unit-I

Definition of transducer. Advantages of an electrical signal as out-put. Basic requirements of transducers, Primary and Secondary Transducer, Analog or digital types of transducers. Resistive, inductive, capacitive, piezoelectric, photoelectric and Hall Effect tranducers.

Unit-II

Measurement of Pressure – Manometers, Force summing devices and electrical transducers **Measurement of Temperature** – Metallic resistance thermometers, semi conductor resistance sensors (Thermistors), thermo-electric sensors, pyrometers.

Unit-III

Measurement of Displacement – Potentiometric resistance type transducers, inductive type transducers, differential transformer (L.V.D.T), capacitive transducers, Hall effect devices, strain gage transducers. **Measurement of Velocity** – variable reluctance pick up, electromagnetic tachometers, photoelectric tachometer, toothed rotor tachometer generator.

Unit-IV

Measurement of Force – Strain-gage load cells, pneumatic load cell, LVDT type force transducer. **Measurement of Torque** – Torque meter, torsion meter, absorption dynamometers, inductive torque transducer, digital methods.

Suggested Books:

1. B.C. Nakra, K.K. Chaudhry, "Instrumentation Measurement and Analysis," Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Thomas G. Beckwith etc. all, "Mechanical Measurements (International Student Edition), Addison-Wesley Longman, Inc. England.
3. A.K. Sawhney, " A Course in Electrical and Electronic Measurements and Instrumentation," Dhanpat Rai & Sons, Delhi-6.

Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination
Semester VII (w.e.f. session 2021-2022)

S. No.	Course No.	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1	HM- 904	Intellectual Property Rights for Technology Development & Management	3:0:0	3	3	75	25	0	100	3
2	ECP*	Program Elective-III	3:0:0	3	3	75	25	0	100	3
3	ECP*	Program Elective-IV	3:0:0	3	3	75	25	0	100	3
4	ECP*	Program Elective-V	3:0:0	3	3	75	25	0	100	3
5	ECO*	Open Elective-III	3:0:0	3	3	75	25	0	100	3
6	EC-401L	Project Stage-I	0:0:6	6	3	-	40	60	100	3
7	**EC-403	Industrial Training-III	2:0:0	2	-	-	*100	-	*100	3
		Total		**23**	**18**	**375**	**165**	**60**	**600**	

*** The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.**

**EC-403 is a mandatory credit-less course in which the students will be evaluated for the industrial training undergone after 6th semester and students will be required to get passing marks to qualify.

Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination

LIST OF OPEN ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
VII	ECO-9	Bio-informatics
	ECO-10	Electromechanical Energy Conversion
	ECO-11	Operating Systems
	ECO-12	Robotics
VIII	ECO-13	Machine Learning
	ECO-14	Soft Computing
	ECO-15	Neural Networks and Fuzzy Logic
	ECO-16	Software Defined Radio
	ECO-17	Statistics and Operational Research
	ECO-18	Biomedical Signal Processing
	ECO-19	Internet of Things
	ECO-20	Wireless Sensor Networks

LIST OF PROGRAM ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
VII	ECP-10	Fiber Optic Communications
	ECP-11	Nano electronics
	ECP-12	Microwave Theory and Techniques
	ECP-13	Adaptive Signal Processing
VIII	ECP-14	Wireless Sensor Networks
	ECP-15	Satellite Communication
	ECP-16	High Speed Electronics
	ECP-17	Wavelets
	ECP-18	Embedded systems
	ECP-19	Mixed Signal Design
	ECP-20	Error correcting codes
	ECP-21	Digital Image & Video Processing
	ECP-22	Mobile Communication and Networks
VIII	ECP-23L	IoT Lab
	ECP-24L	Artificial Intelligence and Data Science Lab
	ECP-25L	Robotics Lab
	ECP-26L	Wireless Communication Lab
	ECP-27L	Microwave Communication Lab
	ECP-28L	Biomedical Lab

Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination
Semester VIII(w.e.f. session 2021-2022)

S. No.	Course No.	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam. (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	ECP*	Program Elective-VI	3:0:0	3	3	75	25	0	100	3
2	ECP*	Program Elective-VII	3:0:0	3	3	75	25	0	100	3
3	ECO*	Open Elective-IV	3:0:0	3	3	75	25	0	100	3
4	ECO*	Open Elective-V	3:0:0	3	3	75	25	0	100	3
5	EC-402L	Project Stage-II	0:0:10	10	5	-	40	60	100	3
6	ECP*	Program Elective Labs	0:0:4	4	2	-	40	60	100	3
		Total		**26**	**19**	**300**	**180**	**120**	**600**	

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Bachelor of Technology (Electronics & Communication Engineering) (Credit Based)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination

LIST OF OPEN ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
VII	ECO-9	Bio-informatics
	ECO-10	Electromechanical Energy Conversion
	ECO-11	Operating Systems
	ECO-12	Robotics
VIII	ECO-13	Machine Learning
	ECO-14	Soft Computing
	ECO-15	Neural Networks and Fuzzy Logic
	ECO-16	Software Defined Radio
	ECO-17	Statistics and Operational Research
	ECO-18	Biomedical Signal Processing
	ECO-19	Internet of Things
	ECO-20	Wireless Sensor Networks

LIST OF PROGRAM ELECTIVES (B.TECH. ECE)		
SEM	**CODE**	**SUBJECT**
VII	ECP-10	Fiber Optic Communications
	ECP-11	Nano electronics
	ECP-12	Microwave Theory and Techniques
	ECP-13	Adaptive Signal Processing
VIII	ECP-14	Wireless Sensor Networks
	ECP-15	Satellite Communication
	ECP-16	High Speed Electronics
	ECP-17	Wavelets
	ECP-18	Embedded systems
	ECP-19	Mixed Signal Design
	ECP-20	Error correcting codes
	ECP-21	Digital Image & Video Processing
	ECP-22	Mobile Communication and Networks
VIII	ECP-23L	IoT Lab
	ECP-24L	Artificial Intelligence and Data Science Lab
	ECP-25L	Robotics Lab
	ECP-26L	Wireless Communication Lab
	ECP-27L	Microwave Communication Lab
	ECP-28L	Biomedical Lab