Proposed Course Structure of B. Tech in ECE at NERIST (4 Years)

Year I						**Semester - I**
S.N.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	PH21101	Physics	4	0	2	05
2.	MA21101	Mathematics – I	3	1	0	04
3.	ES211**	Basic Electrical Engineering (offered by EE)	3	1	2	05
4.	ES211**	Engineering Graphics and Design (offered by CE+ME)	0	0	6	03
5.	FR21121	Biology for Engineers	2	1	0	03
		Total				**20**

Semester - II

S.N.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	CY21101	Chemistry	3	1	2	05
2.	MA21201	Mathematics – II	3	1	0	04
3.	ES212**	Programming for Problem Solving (offered by CS)	3	0	2	04
4.	ES212**	Workshop Practices (offered by ME)	0	0	6	03
5.	HS212**	English	2	0	2	03
6.	ES121**	Environmental Science	2	0	0	00
		Total				**19**

Year II **Semester - III**

S.N.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	MA22101	Mathematics – III	3	1	0	04
2.	ES221**	Engineering Mechanics (offered by CE+ME)	3	1	0	04
3.	ES221**	Basic Electronics Engineering (offered by ECE)	3	0	2	04
4.	EC22101	Electronic Instrumentation and Measurements	3	0	2	04
5.	EC22102	Digital Electronics	2	1	2	04
6.	EC22103	Signals and Systems	2	1	0	03
		Total				**23**

						Semester - IV
S.N.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	HS222**	Entrepreneurship and Start Ups	3	0	0	03
2.	HS22277	Indian Constitution	-	-	-	00
3.	EC22201	Microprocessors and Applications	3	0	2	04
4.	EC22202	Analog Communication Systems	3	0	0	03
5.	EC22203	Linear Integrated Circuits	2	1	2	04
6.	EC22204	Circuits and Devices	2	1	2	04
7.	EE22204	Power Electronics (offered by EE)	3	0	0	03
		Total				**21**

Year-III **Semester - V**

S.N.	Course Code	Course Title	L	T	P	Credit
1.	HS231**	Principles of Economics	3	0	0	03
2.	HS231**	Essence of Indian Traditional Knowledge	-	-	-	00
3.	MA23101	Applied Probability and Statistics	3	0	0	03
4.	EC23101	Digital Design using HDL	2	1	2	04
5.	EC23102	Digital Signal Processing	3	0	2	04
6.	EC23103	Electromagnetic Theory	3	0	0	03
7	EC23104	Control Systems	3	0	0	03
		Total				**20**

Semester - VI

S.N.	Course Code	Course Title	L	T	P	Credit
1	HS232**	Organizational Behaviour	3	0	0	03
2	**23***	Open Elective – I (From MOOC)	3	0	0	03
3	EC230**	Programme Elective – I	3	0	0	03
4	EC230**	Programme Elective – II	3	0	0	03
5	EC23289	Seminar	0	0	2	01
6	EC23201	Digital Communications	3	0	2	04
7	EC23202	Microwave Engineering	3	0	2	04
8	EC23203	Microelectronics	3	0	0	03
		Total				**24**

Year IV **Semester - VII**

S.N.	Course Code	Course Title	L	T	P	Credit
1.	**24***	Open Elective - II	3	0	0	03
2.	EC240**	Programme Elective - III	3	0	0	03
3.	EC240**	Programme Elective - IV	3	0	0	03
4.	EC24101	Antenna and Radar Engineering	3	0	2	04
5.	EC24102	VLSI Designs	3	0	2	04
6.	EC24199	Project –I	0	0	6	03
7.	EC24179	Industrial Training (Four weeks)	0	0	0	03
		Total				**23**

Semester - VIII

S.N.	Course Code	Course Title	L	T	P	Credit
1.	**242**	Open Elective – III (From MOOC)	3	0	0	03
2.	**242**	Open Elective - IV	3	0	0	03
3.	EC240**	Programme Elective – V	3	0	0	03
4.	EC240**	Programme Elective – VI	3	0	0	03
5.	EC24299	Project –II	0	0	12	06
6.	ED24288	Extra-Curricular Activities and Discipline	0	0	0	02
		Total				**20**

	PROGRAMME ELECTIVE-1	L	T	P	C
EC23001	Network Analysis and Synthesis	3	0	0	3
EC23002	Video and Advanced TV Engineering	3	0	0	3
EC23003	Modern Control Engineering	3	0	0	3
EC23004	Information Theory and Coding	3	0	0	3
EC23005	Medical Electronics	3	0	0	3
EC23006	Speech Processing	3	0	0	3
	PROGRAMME ELECTIVE-2	**L**	**T**	**P**	**C**
EC23007	Microcontrollers and Applications	3	0	0	3
EC23008	Computer Organization	3	0	0	3
EC23009	Introduction to Plasmonics	3	0	0	3
EC23010	Embedded Systems	3	0	0	3
EC23011	Transducers and Signal Conditioning	3	0	0	3
EC23012	Digital Image Processing	3	0	0	3
	PROGRAMME ELECTIVE-3	**L**	**T**	**P**	**C**
EC24001	Multimedia Communication and Networking	3	0	0	3
EC24002	Telecommunication Switching	3	0	0	3
EC24003	Optical Fiber Communication	3	0	0	3
EC24004	Wireless Communication	3	0	0	3
EC24005	Instrumentation and Process Control	3	0	0	3
EC24006	Artificial Intelligence and Machine Learning	3	0	0	3
	PROGRAMME ELECTIVE-4	**L**	**T**	**P**	**C**
EC24007	Advanced Digital System Design	3	0	0	3
EC24008	Semiconductor Device Modelling	3	0	0	3
EC24009	Advanced Computer Architecture.	3	0	0	3
EC24010	Nano-electronics	3	0	0	3
EC24011	Low Power VLSI Design.	3	0	0	3
EC24012	Advance Digital Signal Processing	3	0	0	3
	PROGRAMME ELECTIVE-5	**L**	**T**	**P**	**C**
EC24013	Artificial Neural Networks and its Application	3	0	0	3
EC24014	Modern Digital Communication Techniques	3	0	0	3
EC24015	Satellite Communication	3	0	0	3
EC24016	Computer Communication and Network	3	0	0	3
EC24017	Wireless Sensor Networks.	3	0	0	3
EC24018	RF Components and Circuits	3	0	0	3
	PROGRAMME ELECTIVE-6	**L**	**T**	**P**	**C**
EC24019	Analog Integrated Circuit	3	0	0	3
EC24020	Digital Integrated Circuit	3	0	0	3
EC24021	Computer Aided Design of VLSI Circuits	3	0	0	3
EC24022	VLSI Digital Signal Processing Systems	3	0	0	3
EC24023	CMOS Mixed Signal Circuits	3	0	0	3
EC24024	VLSI implementation of DSP architecture	3	0	0	3
EC24025	System and Data Security	3	0	0	3
EC24026	Data Analytics	3	0	0	3

	OPEN ELECTIVE	L	T	P	C
EC24041	Electronic Circuit and Devices	3	0	0	3
EC24042	Instrumentation and Measurements	3	0	0	3
EC24043	Electronic Engineering Materials	3	0	0	3

Department:	**Electronics and Communication Engineering**				
Couse Number:	ES-221**				
Title of the Course:	Basic Electronics Engineering				
Designation:	REQUIRED course				
Pre-Requisite:	PH211**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	**5**	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: To understand the basics of semiconductor physics and diodes.
CO2: To learn about Transistor operations, various modes of operation and its biasing.
CO3: Study of transistors AC models.
CO4: Study of voltage regulator power amplifiers and its types.

Topic Covered:		**Lectures**
UNIT-I	Semiconductors and diode**:** Conduction in solids. Pure and doped semiconductor, Concept of holes, Electron and hole mobility, Band Diagram. Diode : p-n junction diode, diode mechanism & I-V characteristics, Equivalent circuits of diodes, Avalanche and Zener effect, Zener diode , LED, Schottky diode. Application: Half wave and Full wave rectifier circuits, clipping and clamping circuits, zener voltage regulator circuit.	12
UNIT-II	Bipolar Junction Transistors: Operation ofN-P-N and P-N-P transistors in active, saturation and cut-off modes. I-V characteristics, current and voltage gain in CE,CB and CC configuration. Transistor biasing circuits, and stability, ac dc load line concept	10
UNIT-III	Transistor AC Analysis: Low frequency and high frequency models for BJT, BJT Amplifiers, h parameters /r-parameter model, high frequency π model. Miller's theorem.	10
UNIT-IV	Voltage regulators and Power Amplifiers:Series and Shunt voltage regulators.Introduction to Power amplifiers – Class A, B, AB, C, Push pull & Tuned amplifier.	8

Text Books/ Reference Material:

1. Physics of Semiconductor Devices, (S M Sze and Kwok K. Ng, 3rdEdition), Wiley- Interscience.
2. Solid State Electronic devices, Streetmann and Banerjee (7th Edition),Prentice Hall, 2014.Millman&Halkias, “Integrated Electronics”(3rd Edition), Tata McGraw Hill.
3. Semiconductor Physics & Devices: Basic Principle, Donald A. Neaman, (3rd Edition), Tata McGraw Hill, New Delhi.
4. Electronic Devices and Circuit Theory, Robert L. Boylestad, Louis Nashelsky, 10th Edition, Pearson
5. Electronics Principles By: A. P. Malvino, Tata McGraw Hill

Department:	**Electronics and Communication Engineering**				
Course Number:	EC-22101				
Title of the Course:	Electronic Instrumentation and Measurements				
Designation:	REQUIRED course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Study of different measurement terminology and dynamic response of measuring Instruments

CO2: Understand the concepts of popular instruments like analog, digital andcathode ray oscilloscope.

CO3: Acquire the concept and use of different types of bridges.

CO4: Study of different types of transducers and their application.

Topic Covered:		**Lectures**
UNIT-I	Generalized Measurement system: Accuracy, Precision, Fidelity, speed of response, static & dynamic performance characteristics, dynamic- step response, ramp response of first and second order instruments. Classifications of errors, error analysis of measurement.	8
UNIT-II	Analog and Digital instruments: PMMC Galvanometer, Analog multimeter, range extension of voltmeter and ammeter, Series and shunt ohmmeter. Digital multimeter, Signal generator and Function generator. Cathode Ray Oscilloscope, basic of CRO circuit and components. Uses of CRO for different measurement. Lissajous pattern.	14
UNIT-III	AC and DC Bridges: Introduction to DC and AC bridges for measurement of voltage / current / resistance /capacitance and inductance.	10
UNIT-IV	Definition of transducer, classification, resistive, capacitive, inductive, magnetic, optical, piezoelectric, pneumatic.	8

Text Books/ Reference Material:

1. Principles of Electronics instrumentation and measurements. Berlyn and Getz(McMillan Pub. Co.)
2. A Course in Electrical Electronics Measurements and instrumentation. A.K. Sawhney (Dhanpat Roy & Co.).
3. Modern Electronics Instrumentation and Measurement Techniques Albert D. Heltrick, W. D. Cooper. (PHI).

4.Transducers & Instrumentation, Murthy DVS, PHI, ND, 1995.

5. Elements of Electronic Instrumentation and Measurement. Joseph J. Carr. Pearson Education
6. PC-Based Instrumentation Concept and Practice N. Mathivanan PHI

Department:	**Electronics and Communication Engineering**				
Course Number:	EC-22102				
Title of the Course:	Digital Electronics				
Designation:	REQUIRED course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	2	1	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Acquire knowledge about basics of digital electronics, number systems and Booleanalgebra.

CO2: Analyze and design digital combinational circuits for SSI, LSI and MSI circuits

CO3: Understand the operation of different types of logic families and MSI chips.

CO4: Analyze and design of sequential digital circuits.

Topic Covered:		**Lectures**
UNIT-I	Number System and Boolean Algebra: Binary Numbers. Hexadecimal number, r's complement & (r-1)'s complement, binary addition, subtraction, binary multiplication and Division. Codes and their conversions: BCD, Octal, Hexadecimal, ASCII, Gray, Excess 3. Boolean Algebra: Boolean identities, De Morgan's theorems. SOP, POS. Concepts of min term and max terms. AND-OR networks. Algebraic Simplification. Karnaugh Map , MEV technique and Quine-McClusky method	10
UNIT-II	Combinational Circuit: Basic logic gates and universal Gate. Design of Combinational logic circuit. Half Adder, Full adder, Ripple Carry adder, the carry look-ahead adders. Half- Subtractor, Full Subtractor, code converter, decoder, multiplexer, de-multiplexer parity generator and checker.	10
UNIT-III	Logic Families: Different Logic families- TTL, ECL, MOS and CMOS, their operation Circuits for INVERTER, NAND, NOR. Transfer Characteristics, noise margin, propagation delay, fan in fan out, power dissipation consideration	6
UNIT-IV	Data Processing Circuits MSI CHIPS: Multiplexer, Decoder, Decoder driver, 7 segment display decoder driver, Encoders Octal to Binary, Decimal to BCD encoders, Priority encoders. Implementation of combinational circuit by MSI chip.	6
UNIT-V	Introduction to sequential circuits: Latch, R-S, J-K, D flip flops, Master Slave, arrangement, Edge triggered flip flops, shift registers, asynchronous and synchronous counters	8

Text Books/ Reference Material:

1.Digital Systems: Principles and Applications, Ronald J .Tocci, 6th Ed, PHI
2. Digital Principles and Applications, A.P.Malvino, D.P.Leach, 4th Ed ,TMH
3. Fundamentals of Logic Design, C.A.Roth, Jr., Jaico, 4th Ed, Publishing House.
4. Digital Design. Morris Mano. 4th Ed. PHI, 2008
5. Fundamentals of Digital Circuits, A. Anand Kumar, 4th Ed. PHI, 2016
6. Digital Integrated Electronics- H.Taub& D. Shilling, 1st Ed. MGraw Hill.
7. Modern Digital Electronics R.P Jain, 4th Ed. TMH, 2010
8.Digital Fundamentals, T. L. Floyd,(9th Edition), Prentice Hall.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC22103				
Title of the Course:	Signals and Systems				
Designation:	REQUIRED course				
Pre-Requisite:	MA212**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	2	1	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Represent and characterize the signals and systems using linear algebra.

CO2: Classify systems based on their properties and determine the response of LTI system using convolution.

CO3: Analyse the spectral characteristics of continuous-time and discrete-time periodic aperiodic signals using Fourier analysis.

CO4: Apply the Laplace transform and Z- transform to analyse continuous-time and discrete-time signals and systems and understand the process of sampling and the effects of under Sampling.

Topic Covered:		**Lectures**
UNIT-I	Continuous and discrete time signals: Classification of Signals, Transformation of independent variable of signals, Basic continuous-time and discrete-time signals. Energy and power signals. Unit Impulse, Unit Step Functions and Ramp Function. Periodic and aperiodic signals, Orthogonal signal.	6
UNIT-II	Basic system properties: Analysis of Continuous-time and Discrete-time LTI Systems and their properties. Linear constant co-efficient differential equations and difference equations.	8
UNIT-III	Fourier-series and Fourier Transform representation of Continuous-time Signals and their properties. Discrete-Time Fourier-series and Discrete-Time Fourier Transform representation of discrete-time Signals and their properties.	8
UNIT-IV	Laplace Transform and its properties. Unilateral Laplace Transform. Analysis of LTI systems using Laplace-transform. Z-transform and its properties. Unilateral Z-Transform. Analysis of LTI systems using Z - transform.	8
UNIT-V	State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems.	10

Text Books/ Reference Material:

1. Signals & Systems, Alan V. Oppenheim, Alan S. Willsky , S. Hamid Nawab, 2nd Ed., Pearson Education. 2013
2. Signals and Systems, S.Haykin and B. VanVeen , 2nd Ed. Wiley.2007
3. Principles of Linear Systems and Signals, B.P. Lathi, 2nd Ed. Oxford.2009
4. Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press.
5. Introduction to Signals and Systems, Douglas K. Lindner, McGraw Hill.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC22201				
Title of the Course:	Microprocessors and Applications				
Designation:	REQUIRED course				
Pre-Requisite:	EC22102				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Discuss the architecture of 8085 processor, instruction sets and timing diagram.
CO2: Have the concept of micro and macro programming.
CO3: Understand various interrupts and the concept of interfacing.
CO4: Understand the basics of 16-bit processor

Topic Covered:		**Lectures**
UNIT-I	Microprocessors: Evolution of microprocessor, Architecture of Intel 8085A microprocessor. Register organization, pin description. Instruction sets, operand addressing modes, instruction cycle, machine cycle, Timing diagram, Mapping of I/O to microprocessor	10
UNIT-II	Programming: Concept of Micro and Macro programming, arithmetic and logical computations, block of data moving looping, counting, time delaying operations. Stack and subroutines, Concept of stack memory.	10
UNIT-III	Interrupts and Peripherals: Vectored interrupts, maskable and unmaskable interrupts. Intel 8085 software and hardware interrupts and their working mechanism. Usage of RIM, and SIM instructions. Peripherals: Introduction to I/O addressing. Study of peripherals like Intel 8255, 8257, 8254 and 8251. Interfacing of I/O to microprocessor.	10
UNIT-IV	Evolution of 16-bit microprocessors from the 8 bit 8085: Introduction to Intel 8086/8088 microprocessor architecture, Architecture, Addressing Modes, Data Movement, Arithmetic and Logic operations, Concept of segmentation and computation of physical addresses. The maximum and minimum mode of operation of 8086 processor.	10

Text Books/ Reference Material:

1. Microprocessor Architecture Programming Application with the 8085/8080A, R.S. Gaonkar, 6th Ed. Prentice Hall of India, 2013
2. Intel Corp: The 8085/8085A. Microprocessor Book–Intel marketing communication, Wiley intersciencepublications, 1980.
3. Intel Corp. Micro Controller Handbook–Intel Publications,1994.
4. Microprocessors and Interfacing, Douglas V. Hall, McGraw Hill International Ed.
5. Assembly Language Programming the IBMPC, Alan R. Miller, SubexInc, 1987
6. Bary B. Brey, “TheIntelMicroprocessors:8086/8088,80186,80286,80386 & 80486” Prentice Hall, India
7. Introduction to Microprocessors, A.P. Mathur, 3rd Ed. Tata McGraw Hill,2001
8. Fundamental of Microprocessor and Microcomputers, B. Ram, 1st Ed. Dhanpat Rai

Department:	**Electronics and Communication Engineering**
Course Number:	EC22202
Title of the Course:	AnalogCommunication Systems
Designation:	REQUIRED course
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Learn about the signals used in communication, basic signal analysistechniques.
CO2: Have the concept of AM, FM, PM modulation techniques.
CO3: Understand and analyse noise and random signal theory.
CO4: Interpret the concept of communication receiver and its basic theory.

Topic Covered:		**Lectures**
UNIT-I	Introduction to various types of signals used in communication engineering and their Mathematical representations. Review of Fourier series, Fourier Transform.	8
UNIT-II	Study and analysis of AM, FM and PM and their respectiveDemodulation Techniques, Advantages of FM over AM. AM Limiters. Pre-emphasis and De-emphasis. Transmitters for AM, FM, SSB, ISB systems.	10
UNIT-III	Introduction to Pulse Modulation techniques- PAM, PPM, PDM and PCM systems. TDM and FDM systems and their comparison.	6
UNIT-IV	Review of random signals and noise, signal to noise ratio in amplitude and angle modulated systems. Thermal and shot noise, White noise and filtered noise, AWGN Properties, Noise equivalent bandwidth concept. Discrete probability theory, Continuous random variables, Statistically independent random variables, Probability density functions of sums, Transformation of density functions, Ergodic functions, Auto correlation and Cross Correlation process, Spectral density.	10
UNIT-V	TRF and super heterodyne receiver, AGC, FM receiver, sensitivity, selectivity, image frequency rejection measurements, communication receiver and its special features, PLL, Power Line Carriers & Interfacing with power line.	6

Text Books/ Reference Material:

1. Introduction to Analog and Digital Communication, Simon Haykin, Wiley 2009
2. Electronic Communication Systems, G. Kenedy&Bermard, 4th Ed., TMH 1999
3. Electronics Communication, Roody&J.Coolen, 4th Ed. Prentice Hall1977
4.Principles of Communication System, HTaub and D. L. Schilling, "(2nd Edition), McGraw Hill.
5. Communication System, Carlson, (4th Edition) Tata McGrawHill, New Delhi,
6. Modern Digital and Analog Communication Systems, B P Lathi and Zhi Ding, Oxford University Press.
7. Digital and Analog Communication System, L. W. Couch Li, (6th Edition), Pearson Education, Pvt. Ltd
8. Signal Processing, Modulation and Noise, J A Betts, Hodder & Stoughton Ltd (January 1,1974)
9. Communication Systems,SimanHaykin,(4th Edition), John Wiley.
10. Fundamental of Communication Systems, John G. Proakis and M Salehi, Pearson Education

Department:	**Electronics and Communication Engineering**				
Course Number:	EC22203				
Title of the Course:	Linear Integrated Circuits				
Designation:	REQUIRED course				
Pre-Requisite:	ES221**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	2	1	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: To understand the basic characteristics of a differential amplifier

CO2: To understand the basic characteristics of an OPAMP and its different linear and nonlinear application.

CO3: To understand the principle of oscillation, types of oscillators and design.

CO4: To understand the different types of OPAMP filters, and data convertors.

Topic Covered:		**Lectures**
UNIT-I	Differential Amplifiers (DA): Single ended and fully differential output topology, voltage gain, CMRR, PSRR and ICMR and output swing of BJT-based DA., active loads, IC biasing, current source and sink, current mirrors, level translators' circuits.	10
UNIT-II	OPAMP: Block-level and internal circuit level working of op-amp, ideal characteristics, open loop gain, negative feedback configurations with closed loop gain, various linear applications adder, subtractor, averager, precision rectifiers, integrator, differentiator, log and antilog amplifiers, absolute value detectors, voltage limiters, instrumentation amplifier etc., non-linear applications such as comparators, zero crossing detector, analog multipliers, etc.	12
UNIT-III	OSCILLATORS: Classification, Barkhausen Criterion, frequency stability, inverting and non-inverting Schmitt triggers, integrator, square wave and triangular wave oscillators, Phase Shift Oscillator, Wein Bridge Oscillator, voltage-controlled oscillator (VCO) circuit design using OP-AMP, PLL.	8
UNIT-IV	ACTIVE FILTERS and CONVERTERS: classification and characterization of filters, Various types of active RC-filters of first order and second order and their design. State variable Biquadratic filters. Converters: Various types of Analog to Digital and Digital to Analog Converter, working principle, characteristics.	10

Text Books/ Reference Material:

1. Op-Amps and Linear Integrated Circuits 4 Edition Author(s): Ramakant A. Gayakwad Publisher: PHI earning (2009)
2. Linear Integrator Circuits by D.R. Chaudhury and S.B. Jain, New age International Publishers, FourthEdition
3.Operational Amplifiers with Linear Integrated Circuits 4th Edition, Author(s):William D. Stanley, Publisher: Pearson (2004)
4. Electronics Principles By: A. P. Malvino, Tata McGraw Hill
5. Integrated Electronic circuits By: J. Millman and C.C.Halkias, TMH.
6. Electronic Devices and Circuits, Fourth Edition by David A. Bell. (PHI).
7. Electronics Circuits By: D. Shilling, Tata McGraw.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC22204				
Title of theCourse:	Circuits and Devices				
Designation:	REQUIRED course				
Pre-Requisite:	ES221**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	2	1	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: To learn about Transistor operations, FETs and MOSFETs various modes of operationand its frequency response.

CO2: To study concept of feedback and stability for amplifiers

CO3: To study different types of oscillator circuits.

CO4: To learn about multistage amplifiers and tuned amplifiers.

Topic Covered:		**Lectures**
UNIT-I	FET and MOSFET: Operation and Structure of FETs, Junction field effect transistor (JFET), MOS Capacitor, MOSFET types, biasing, Small signal parameters. Common Drain, Common source and common gate amplifiers, CMOS	12
UNIT-II	Feedback amplifier: Feedback concept, characteristics of negative and positive feedback. Four feedback topologies, effect of negative and positive feedback on input impedance, output impedance, voltage gain, band width, noise frequency, de-sensitivity factor and stability.	8
UNIT-III	Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.	8
UNIT-IV	Multistage amplifier: Need, Gain expression, types - RC coupled,transformer coupled, direct coupled, and their frequency response and Bandwidth. Cascode amplifiers Tuned Amplifiers: Need for tuned circuits, Single, Double tuned and Synchronously tuned amplifiers.	12

Text Books/ Reference Material:

1. Fundamentals of Microelectronics, BehzadRazavi, John Wiley & Sons.
2. Electronic Devices and Circuits, Fourth Edition by David A. Bell. (PHI).1st Ed
3. Electronics Principles By: A. P. Malvino, TMH. 2nd Ed. 2008
4. Microelectronic by Adel S. Sedra and C Smith, Oxford university press.4th Ed.
5. Integrated Electronic circuits By: J. Millman and C.C. Halkias, 4th Ed.TMH.
6. Electronics Circuits By: D. Shilling, 3rd Ed. Tata McGraw 2002
7. Microelectronics,J. Millman and A. Grabel, 2nd edition, McGraw Hill, 1988.
8. Semiconductor Physics & Devices: Basic Principle,Donald A. Neaman, ”,(3rd Edition), Tata McGraw Hill,New Delhi.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23101				
Title of the Course:	Digital Design using HDL				
Designation:	REQUIRED course				
Pre-Requisite:	EC22102				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	2	1	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1:	Design and analyse sequential logic circuits and synchronous finite state machines.
CO2:	To learn the Basics of HDL modelling and design techniques.
CO3:	To Design controller using ASM chart method.
CO4:	Design and analysis of asynchronous finite state machines.

Topic Covered:		**Lectures**
UNIT-I	Introduction to sequential circuits: Latch, R-S, J-K, D flip flops, Master Slave arrangement, Edge triggered flip flops, Conversion of flip flop, shift registers, asynchronous and synchronous counters	6
UNIT-II	Design tools: Introduction to HDL Basic features of HDL. Simulation and synthesis. Basic HDL modelling techniques. Algorithmic level design. Register Level Design. HDL-based design techniques. Modelling for synthesis.	8
UNIT-III	Synchronous sequential finite state machines: Synchronous analysis process, design approaches, state reduction, design of next state decoder and output decoder, design of counters and decoders, code sequence detector, sequential code generators	8
UNIT-IV	Algorithmic State Machine (ASM): ASM Chart, ASM block, Design using FFs, Design using multiplexers and PLAs.	8
UNIT-V	Asynchronous Sequential finite state machines: Need for asynchronous circuit analysis, cycles and races, Hazards, map entered variable Approaches to asynchronous design.	10

Text Books/ Reference Material:

1. An Engineering approach to Digital Design, William J. Fletcher PHI
2. VHDL Primer, J. Bhaskar
3. Verilog HDL Synthesis, A Practical Primer, J. Bhaskar
4. Digital Design: Principles and Practices, John F. Wakerly, PHI
5. Fundamentals of Digital Circuits, A. Anand Kumar, PHI
6. Digital Design. Morris Mano. PHI
7. Digital Principles and Design Donald D. Givone TMH

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23102				
Title of the Course:	Digital Signal Processing				
Designation:	REQUIRED course				
Pre-Requisite:	EC 22103				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Understand signal processing systems using basic concepts.

CO2: Analyze signal using the discrete Fourier transform and its effective computation by FFT techniques.

CO3: Specify and design FIR and IIR type digital filters and identify the fundamentals of multi rate signal processing and its applications.

CO4: Understand advanced digital signal processing techniques.

Topic Covered:		**Lectures**
UNIT-I	Review of Discrete-time Fourier Transform, Frequency response of discrete time systems, All pass inverse and minimum phase systems.	5
UNIT-II	DFT, Relationship of DFT to other transforms, FFT, DIT and DIF algorithms, Linear filtering using DFT and FFT.	8
UNIT-III	Frequency response of FIR filter, Design of FIR Digital filters, Window method, Park-McClellan's method, Frequency Sampling Method, Design of IIR Digital Filters, Butterworth, Chebyshev and Elliptic Approximations, Lowpass, Bandpass, Bandstop and High pass filters, Mapping formulas, Frequency transformations.	11
UNIT-IV	Direct form realization of FIR and IIR systems, Lattice structure for FIR and IIR systems, Finite-word length effects. Limit cycle oscillations.	6
UNIT-V	Multirate signal processing – Sampling rate conversion – applications of multirate signal processing. Parametric and non-parametric spectral estimation. Application of DSP.	10

Text Books/ Reference Material:

1. Digital Signal Processing, Algorithms and Applications, Proakis and Manolakis, 3rd edition, Prentice Hall of India, New Delhi.
2. Discrete-time Signal processing, Alan V Oppenheim and Ronald W Schafer, 3rd edition, Pearson.
3. The Scientist & Engineer's Guide to Digital Signal Processing, Steven W Smith.
4. Understanding Digital Signal Processing, Richard G Lyons, Pearson.
5. Digital Signal Processing: A Practical approach, EmmanualC.Ifeachoret. Al., Pearson Education, 2nd edition.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23103				
Title of the Course:	Electromagnetic Theory				
Designation:	REQUIRED course				
Pre-Requisite:	PH211**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Understand the coordinates systems, vector calculus and apply it in electromagnetic problem
CO2:	Understand the physics of electrostatics and apply it to solve electrostatic problems
CO3:	Understand the physics of magnetostatics and apply it to solve magnetostatics problems
CO4:	Understand the time varying field and waves in different media

Topic Covered:		**Lectures**
UNIT-I	Review of vector Algebra, Rectangular, Cylindrical, spherical Coordinate systems and transformation, Vector Calculus – Gradient, Divergence and curl, Green's and Stroke theorems.	6
UNIT-II	Electrostatics, Coulomb's law. Gauss's law and applications. Electric potential. Poisson's and Laplace equations. Method of images. Electrostatic fields in matter. Dielectrics and dielectric polarization. Capacitors with dielectric substrates.	10
UNIT-III	Magnetostatics, Biot-Savart's Law, Ampere Circuits Law, Applications of Ampere's Law, Maxwell Equations of static fields, Magnetic Scalar and VectorPotentials, Magnetic Force- charge particle, current elements, Magnetic field inMaterial space, Magnetization, Magnetic Boundary Conditions, Inductor,Inductances, Magnetic Energy.	10
UNIT-IV	Time-varying Fields, Faraday's Law, Transformer and Motional Electromotive Forces, Displacement current, Maxwell Equations, Time Varying Harmonic Fields.	6
UNIT-V	Electromagnetic waves, General wave Equations, waves in lossy dielectrics, Plane wave in lossless dielectrics, free space, good conductors, Wave polarization, Poynting vector and reflection of waves	8

Text Books/ Reference Material:

1. Elements of Electromagnetics 4th Edition – M. N. O. Sadiku, Oxford.
2. Electromagnetic waves and radiating systems, 2th edition, E. Jordan and K. Balmin, Prentice Hall of India, New Delhi, 2001.
3. Advanced Engineering Electromagnetics, C.A. Balanis, John Willy and Sons, New York, 2001.
4. Electromagnetics, 4th edition, J.D.Kraus, Tata McGrawhill, New Delhi, 1991.

Department: **Electronics and Communication Engineering**
Course Number: EC23104
Title of the Course: Control systems
Designation: REQUIRED course
Pre-Requisite:

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Realize block diagrams, mathematical model and transfer functions of open and closed loop control systems.

CO2: Have an in-depth knowledge on transient, steady state and stability of a control system.

CO3: Specify control system performance in the frequency-domain in terms of gain and phase margins, design compensators to achieve the desired performance.

CO4: Model and analyze control systems using state-space analysis and knowledge on digital control System.

Topic Covered:		**Lectures**
UNIT-I	Elementary control concepts: Open loop and close loop control system.Transfer function, impulse response, modeling of electrical and mechanical (translational and rotational) systems, DC motor block diagramsimplification, and signal flow graphs.	8
UNIT-II	Transient response analysis of I and II order system: Type of systems andits effect on error function, stability, steady state error.	6
UNIT-III	Stability concept: Routh Hurwitz criterion of stability, Root locustechniques: Root-Loci and complementary root loci rules for root locusplots.	7
UNIT-IV	Frequency Response Analysis: Nyquist plot and Bode plot. Gain and phasemargins, compensation typical examples. Compensators and controllers: lead, lag and lag-lead compensators,proportional, PI and PID controllers.	9
UNIT-V	State Space Analysis: State Variables and State Model, State TransitionMatrix and its properties, Concept of Controllability and Observability.Digital Control System: Sampled Data Control System, Step Response(First & Second Order Systems), Introduction to Digital PID Controller,block schematic of PLC and addressing.	10

Text Books/ Reference Material:

1. Control Systems Engineering, Nagaratha and Gopal.
2. Discrete-Time Control Systems, K. Ogata, Pearson Education/PHI, 2 Edition
3. Modern Control Engg, K.Ogata, 2nd ed., PHI, 1995
4. Automatic Control Systems, B.C.Kuo, 7th ed., PHI, 1995.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23201				
Title of the Course:	Digital Communications				
Designation:	REQUIRED				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Understand data conversion techniques.
CO2: Understand digital modulations.
CO3: Familiarize with digital data transmission techniques.
CO4: Familiarize with information theory and coding schemes.

Topic Covered:		**Lectures**
UNIT-I	Review of Sampling theorem, Pulse-Amplitude Modulation, Channel bandwidth. Natural and Flat top sampling. Quantization of signals, Quantization error, Pulse-code modulation (PCM), Electrical representation of binary digits, PCM system, Companding, Multiplexing. Differential PCM, Delta modulation, Adaptive delta modulation, Vocoders, Channel Vocoder, Linear Predictive coder.	10
UNIT-II	Digital Modulation Techniques: Binary Phase-Shift Keying (BPSK), Differential Phase-Shift Keying, Differentially Encoded PSK (DEPSK), Quadrature Phase- Shift Keying (QPSK), Quadrature Amplitude Shift Keying (QASK), Binary Frequency-Shift Keying (BFSK), Similarity of BPSK and BFSK, M-ary FSK, Minimum Shift Keying (MSK).	12
UNIT-III	Data Transmission: Baseband signal receiver, Probability of error. Matched Filter, Probability of error in Matched filter, Coherent reception of PSK and FSK, Non-Coherent reception of FSK, PSK and QPSK. Error probability of BPSK, BFSK and QPSK. Bit-by-bit encoding versus Symbol-by-Symbol encoding, Relationship between Bit error rate and Symbol Error rate, comparison of modulation systems.	12
UNIT-IV	Information Theory and Coding: Discrete messages, information, Entropy, Information rate, coding to increase average information per bit. Shannon's theorem, Capacity of Gaussian channel, Bandwidth-S/N trade off, use of orthogonal signals to attain Shannon's limit, Efficiency of orthogonal signal transmission, Coding: Parity check bit coding, error detection and error correction coding, Block codes, Convolution codes, Comparison of error rates in coded and uncoded transmission.	6

Text Books/ Reference Material:

1. Electronic Communications Systems, Wayne Tomasi, Pearson Education
2. Principles of Communication Systems, Taub and Schilling TMH.
3. Digital Communication, S. Haykin, Wiley.
4. Analog and Digital Communication, S. Haykin, Wiley.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23202				
Title of the Course:	Microwave Engineering				
Designation:	REQUIRED course				
Pre-Requisite:	EC23103				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Understand important and unique engineering issues at microwave and millimetrewave frequencies.

CO2: Understand transmission line and use of the smith chart as a graphical tool to solve transmission line problem

CO3: Understand waveguide and use of scattering matrix for analyzing microwave components.

CO4: Understand and analyze the different microwave sources.

Topic Covered:		**Lectures**
UNIT-I	Introduction to Microwave frequencies, systems and measurements., review of Maxwell equations, waves and reflection of waves	8
UNIT-II	Microwave Transmission lines-Transmission line Equations and Solutions, Reflection and transmission Co-efficient, Standing waves and SWR, Line impedance and Admittance, Impedance matching using Smith chart.	8
UNIT-III	Microwave wave guides, Study of Rectangular and Circular Wave guides. Microwave components-rectangular, Circular cavity resonators. Slow wave structures, Sparameters. Wave guide Tees, Directional Couplers, Circulators and Isolators, Hybrid couplers.	8
UNIT-IV	Microwave Sources-Klystrons, Reflex klystrons, TWTs, Hybrid amplifier, BWO. Magnetrons, Forward wave cross-field amplifiers.	8
UNIT-V	Microwave solid state devices-Transistors, Tunnel Diodes, Gunn LSA, InP. Avalanche transit time devices, IMPATT, TRAPATT, and BARITT Diodes, Electron motion in EM field.	8

Text Books/ Reference Material:

1. Foundations of Microwave Engineering, 2nd Ed, R. E. Collin, McGraw
2. Microwave Devices and Circuits, 3rd Ed, Samuel Y. Lio, Prentice Hall of India, New Delhi, 1995.
3. Microwave Engineering 2nd Edition, David M. Pozar, Wiley

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23203				
Title of the Course:	Microelectronics.				
Designation:	REQUIRED course				
Pre-Requisite:	EC22204				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understanding of the fundamentals of semiconductor materials, energy band diagram, types of semiconductors and Fermi Dirac Distribution and carrier dynamics.

CO2: Examine carrier behaviour and application to PN junction and junction properties, light emitting diodes.

CO3: Understand and analyze the internal mechanisms of a BJT.

CO4: Understand the MOS capacitor and Field effect devices.

Topic Covered:		**Lectures**
UNIT-I	Fundamentals of Semiconductors: Crystal Plane. Valence Band Model of Semiconductor. Fermi Dirac probability distribution function. Carrier Concentration in Intrinsic and Extrinsic semiconductors at equilibrium, compensated semiconductor. Carrier transport phenomena- Drift, Diffusion. Excess carriers in semiconductors- Carrier Generation and Recombination. Continuity equation. E-K Diagram. Direct and Indirect semiconductors. Hall Effect.	10
UNIT-II	PN Junction: Energy Band Diagram. Equilibrium state analysis of p-n junction, Forward and Reverse Bias. Forward bias Diode current (minority and majority carrier current). Generation and recombination current. Small signal model of the p-n junction. Metal semiconductor junctions. Light emitting diodes- generation of light, internal quantum efficiency, external quantum efficiency.	10
UNIT-III	Bipolar junction transistors: Principle of Operation. Minority Carrier Distribution Profiles in a Bipolar Junction Transistor. Current Components and Current Gain. Bias modes and operation of bipolar transistor. Non-ideal effects, Base width modulation, High injection effects, emitter ban gap narrowing and emitter current crowding. Breakdown mechanisms in BJTs. BJT small signal equivalent circuit models. Frequency limitations-Time delay Factors, transistor cut-off frequency.	10
UNIT-IV	MOS Fundamentals- Electrostatics of ideal and non-ideal MOS Capacitors. HF and LF capacitance of MOS Capacitors. Theory of operation of MOSFET- Threshold Voltage, I_D-V_D relationship, square-law theory, bulk charge theory. Small-signal equivalent circuits, cut-off frequency. Short channel effects in MOSFETs. JFET introduction and theory of operation. I_D-V_D relationship.	10

Text Books/ Reference Material:

1. Solid-State Electronic Devices, B. Streetman and S. K. Banerjee PHI
2. Semiconductor Physics and Devices, Donald A. Neaman (Tata McGraw-Hill)
3. Semiconductor Device Fundamentals, R. Pierret, Pearson
4. Physics of Semiconductor Devices, S.M.Sze, (Wiley Eastern Ltd)

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24101				
Title of the Course:	Antenna and Radar Engineering				
Designation:	REQUIRED course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1:	Gain knowledge of Antenna and radiation concept.
CO2:	Understand dipole antenna, Antenna Arrays and its design for given specifications
CO3:	Understand and design Microstrip antenna, horn antenna etc.
CO4:	Understand the basic operation of different radar systems

Topic Covered:		**Lectures**
UNIT-I	Antenna fundamentals-Antenna parameters, point source electric doublet, Instantaneous and short dipoles, Quarter and Half wavelength Dipoles, Antenna far –field approximations, Monopoles, Antenna above perfect electric conductor.	12
UNIT-II	Antenna arrays, Loop Antennas.	10
UNIT-III	Introduction of Broadband, Frequency independent antennas- Spiral antennas, log periodic antennas. Aperture antennas, Horn antennas, Microstrip antennas and its analysis.	12
UNIT-IV	Rader fundamentals, Range equation, Different types of radar with practical applications.	6

Text Books/ Reference Material:

1. Antennas, J.D. Kraus, McGraw Hill, 1988.
2. Antenna Theory - Analysis and Design, John Wiley, 1982.
3. R.E. Collin, Antennas and Radio Wave Propagation, C.A. Balanis, McGraw Hill, 1985.
4. Antenna Engineering Handbook, R.C. Johnson and H. Jasik, Mc-Graw Hill, 1984.
5. Micro Strip Antennas, I.J. Bahl and P. Bhartia, Artech House, 1980.
6. Electromagnetic Waves, R.K. Shevgaonkar, Tata McGraw Hill, 2005.
7. Adaptive Antennas,R.E. Crompton, John Wiley. 2016

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24102				
Title of the Course:	VLSI designs				
Designation:	REQUIRED course				
Pre-Requisite:	**EC22204**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	2	5	4

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**	**75% of Theory component**
	Mid-Semester Exam:	**30% of 100**	
	End-Semester Exam:	**50% of 100**	
Practical:	**Class Performance:**	**50% of 100**	**25% of Practical component**
	Practical Exam:	**50% of 100**	
Total Assessment	**Theory 75%**	**Practical 25%**	**100 Marks**

Course Outcomes:

CO1: Understand CMOS technology and be able to do DC and transient analysis of digital CMOS circuits.

CO2: Describe the techniques used for VLSI fabrication and ability to estimate timing characteristics, noise margins, power consumption of a digital VLSI circuit. Design static

CO3: CMOS and dynamic clocked CMOS circuits.

CO4: Analyze working of SRAM cell and DRAM cell

Topic Covered:		**Lectures**
UNIT-I	VLSI design flow Design; MOS Transistor; DC Transfer Characteristics: Static CMOS Inverter DC Characteristics,	8
UNIT-II	CMOS Processing Technology: Layout design rules, CMOS Process enhancements; Stick Diagrams; Technology-Related CAD Issues, Manufacturing Issues.	6
UNIT-III	Delay: Delay Models; Logical Efforts of Paths, Timing Analysis of Delay Models Power: Dynamic Power and Static Power.	6
UNIT-IV	Combinational Circuit Design: CMOS Logic Gates, The Compound Gates, Pass Transistors and Transmission Gates, Tristate buffer, Multiplexers. Circuit Families: Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass-Transistor Circuits. Subthreshold Circuit Design	10
UNIT-V	Sequential MOS logic circuitry: Behavioral of Bistable element, Flip-Flop. Sequencing Static Circuits; Circuit Design of Latches and Flip-Flops; Memory: SRAM; DRAM; Semiconductor memories: Introduction, Read-Only Memory circuits, SRAM circuits, DRAM circuits	10

Text Books/ Reference Material:

1. "CMOS VLSI Design", Pearson Education, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition.
2. "CMOS digital Integrated Circuits, Analysis and Design",Sung-Mo Kang and Yusuf Leblebici, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. "Basic VLSI Design", Douglas.A.Pucknell, KamaranEshraghian, PHI,3rd Edition, 2016
4. "Introduction to VLSI Circuits & Systems", John P. Uyemura Wiley India Edition, 2016

PROGRAMME ELECTIVE-1

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23001				
Title of the Course:	Network Analysis and Synthesis				
Designation:	ELECTIVE course.				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Compute responses of first, second and higher order networks using time domain analysis and Laplace Transform to solve for circuit response
CO2:	Understanding LTI two port systems using the popular parameters and solving them.
CO3:	Synthesizing networks using RL, RC and LC circuits.
CO4:	Applying graph theory for network analysis.

Topic Covered:		**Lectures**
UNIT-I	Review of Network Theorems, Formulations of network equations: First –order systems, Natural response, Initial conditions, complete response of First- order systems, zero state and zero input responses. Second order system, Natural response, Overdamped, Underdamped and critically damped case. Geometry of plane, unit-step and unit impulse response, linear system with sinusoidal inputs, impedance and admittance, power, concept of Complex frequency.	10
UNIT-II	Transform Impedances Network functions of one port and two port networks, concept of poles and zeros, properties of driving point and transfer functions, time response and stability from pole zero plot, frequency response. Characterization of LTI two port networks ZY, ABCD and h-parameters, reciprocity and symmetry. Inter relationships between the parameters, interconnections of two port networks. Transient analysis of different electrical circuits with and without initial conditions.	10
UNIT-III	Positive real function; definition and properties; properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point immittance functions using Foster and Cauer first and second forms	11
UNIT-IV	Graph of a Network, definitions, tree, co tree, link, basic loop and basic cutset, Incidence matrix, cut set matrix, Tie set matrix Duality, Loop and Node methods of analysis.	9

Text Books/ Reference Material:

1. " Network Analysis", M.E. Van Valkenburg, Prentice Hall of India
2. "An Introduction to Circuit analysis: A System Approach" Donald E. Scott McGraw Hill Book Company.
3. 'Circuit Theory" A. Chakrabarti, Dhanpat Rai and Co.
4. "Networks and Systems" D. Roy Choudhary, Wiley Eastern Ltd, 2012

Department:	Electronics and Communication Engineering				
Course Number:	EC23002				
Title of theCourse:	Video and Advanced TV Engineering				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: To understand TV Pictures, Composite Video Signal, Receiver Picture Tubes and Television Camera Tubes.

CO2: To analyse the principles of Monochrome Television Transmitter and Receiver systems.

CO3: To understand the various Colour Television systems with a greater emphasis on PAL system

CO4: To analyse the advanced topics in Television systems and Video Engineering.

Topic Covered:		**Lectures**
UNIT-I	Fundamentals of Television: Geometry form and Aspect Ratio, Image Continuity, Number of scanning lines, Camera tubes, Image orthicon - Vidicon-plumbicon-silicon diode array, Monochrome picture tubes, Composition-vertical sync, Picture signal transmission: Positive and negative modulation, VSB transmission, Sound signal transmission, Standard channel bandwidth.	7
UNIT-II	Monochrome Television Transmitter and Receiver: TV transmitter, TV transmission Antennas, Monochrome TV receiver, RF tuner, UHF, VHF tuner, Digital tuning techniques: AFT-IF subsystems, Video and sound inter carrier detection, Video amplifier circuits, Deflection current waveform, Deflection Oscillators - Frame deflection circuits, EHT generation - Receiver Antennas	7
UNIT-III	Essentials of Colour Television: Compatibility, Colour perception, Three colour theory, Colour television cameras, Colour television display tubes, Colour picture tubes, Pincushion correction techniques: Automatic degaussing circuit, Grey scale tracking, Colour signal transmission, Weighting factors, Formation of chrominance signal.	8
UNIT-IV	Colour Television Systems: NTSC colour TV system, PAL colour TV system: Cancellation of phase errors, PAL -D colour system, PAL coder, Colour burst separation, Burst phase Discriminator, Reference Oscillator, Ident and colour killer circuits, Merits and demerits of the PAL system, SECAM system: Merits and demerits of SECAM system	8
UNIT-V	Advanced Television Systems: Satellite TV technology, Cable TV, Tele Text broadcast receiver, Digital television: Transmission and reception, Projection Television: Flat panel display TV receiver, Sterio sound in TV, 3D TV, EDTV, Digital equipment for TV studios.	10

Text Books/ Reference Material:

1. Monochrome Television Practice, Principles, Technology and servicing, R.R.Gulati, Second edition, New age International Publishes, 2004.
2. Monochrome and colour television, R.R.Gulati, New age Internationl Publisher.
3. Television and Video Engineering, A.M Dhake, Second edition, TMH, 2003.
4. Colour Television, Theory and Practice, S.P.Bali, TMH, 1994.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23003				
Title of theCourse:	Modern Control Engineering				
Designation:	ELECTIVE course				
Pre-Requisite:	**EC23204**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	**0**	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Understand the State Space analysis, Controllability, Observability of control systems
CO2:	Analyse the stability of a system using JHRY criterion, Bilinear Transformation.
CO3:	Analyse discrete control systems in Time Domain as well as in Frequency Domain, design of compensators.
CO4:	Design feedback controllers in digital domain.

Topic Covered:		**Lectures**
UNIT-I	Review of Z-Transforms, State Space Representation of discrete time systems,State transition matrix and its Properties, Discretization of continuous timestate-space equations ,Controllability and Observability,Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function	10
UNIT-II	Stability Analysis, Mapping between the S-Plane and the Z-Plane, Primary strips and Complementary Strips, Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane, Jury stability test, Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion	10
UNIT-III	Design of Discrete Time Control System, Transient and steady-State response Analysis, Design based on the frequency response method, Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers	10
UNIT-IV	State Feedback Controllers & Observers, Design of state feedback controller through pole placement, Ackerman's formula, State Observers	10

Text Books/ Reference Material:

1. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2 Edition.
2. Digital Control Systems, V. I. George, C. P. Kurian, Cengage Learning.
3. Modern Control Engineering, Gopal
4. Digital Control Systems, Kuo, Oxford University Press, 2 Edition, 2003
5. Digital Control and State Variable Methods by M.Gopal, TMH

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23004				
Title of theCourse:	Information Theory & Coding				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Acquire the basic knowledge about entropy and Find nature of random signal and its statistical characteristics

CO2: Understand how to make code optimum in containing information generated by source

CO3: Find the technique to enhance the transmission efficiency of the system

CO4: Understand different modulation techniques such as bandwidth limited and power limited also Find the technique to combat transmission impairments.

Topic Covered:		**Lectures**
UNIT-I	Entropy: Entropy, Joint Entropy and Conditional Entropy, Relative Entropy andMutual Information, Relationship Between Entropy and Mutual Information, Chain Rules for Entropy, Relative Entropy, and Mutual Information, Jensen's Inequality and Its Consequences, Log Sum Inequality and Its Applications, Data-Processing Inequality, Sufficient Statistics, Fano's Inequality	8
UNIT-II	Asymptotic Equipartition Property: Asymptotic Equipartition Property Theorem,Consequences of the AEP: Data Compression, High-Probability Sets and the TypicalSet Data Compression: Examples of Codes, Kraft Inequality, Optimal Codes, Boundson the Optimal Code Length, Kraft Inequality for Uniquely Decodable Codes,Huffman Codes, Some Comments on Huffman Codes, Optimality of Huffman Codes, Shannon–Fano–Elias Coding	8
UNIT-III	Channel Capacity: Examples of Channel Capacity, 7.2 Symmetric Channels,Properties of Channel Capacity, Preview of the Channel Coding Theorem, Definitions, Jointly Typical Sequences, Channel Coding Theorem	7
UNIT-IV	Block Codes Digital communication channel, Introduction to block codes, Single-parity check codes, Product codes, Repetition codes, hamming codes, Minimumdistance of block codes, Soft-decision decoding, Automatic-repeat-request schemesLinear Codes Definition of linear codes, Generator matrices, Standard array, Parity-check matrices, Error syndromes, Error detection and correction, Shortened and extended linear codes	9
UNIT-V	Convolution codes: Encoding convolutional codes, Generator matrices for convolutional codes, Generator polynomials for convolutional codes, Graphical representation of convolutional codes, Viterbi decoder.	8

Text Books/ Reference Material:

1. Joy A. Thomas, Thomas M. Cover, "Elements of information theory", Wiley.
2. S. Gravano, "Introduction to Error Control Codes" OUP Oxford
3. Robert B. Ash, "Information Theory", Dover Publications
4. Error Correction Coding: Mathematical Methods and Algorithms, Todd k Moon, Wiley, 2005.
5. T. S. Rappaport, "Wireless Communication-Principles and practice", Pearson Publications, Second Edition

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23005				
Title of theCourse:	Medical Electronics				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Understanding biomedical signals and specifically cardiological signals like ECG
CO2:	Analyzing biomedical signals in Frequency domain
CO3:	Spectral Analyzing of biomedical signals
CO4:	Understanding adaptive filtering of biomedical signals

Topic Covered:		**Lectures**
UNIT-I	Introduction: General measurement and diagnostic system, classification,Biomedical signal acquisition, difficulties in signal acquisition. ECG: signal origin,parameters-QRS detection different techniques, ST segment analysis, Arrhythmia,Arrhythmia analysis, Arrhythmia monitoring system	8
UNIT-II	ECG Data Reduction, compression: Turning Point, AZTEC, Cortes, FAN,Transformation, Karhunen - Loeve Transform, DPCM, Huffman coding, Datacompression. Signal averaging: Basics, Signal averaging as a digital filter, A typical averager, Software and limitations	8
UNIT-III	Frequency Domain Analysis, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise, motion artefacts and power line interference in ECG, Time Series Analysis: AR models, Estimation of AR parameters, ARMA models. Spectral modelling and analysis of PCG signals	8
UNIT-IV	Spectral Estimation, Evaluation of prosthetic heart valves using PSD techniques. Comparison of the PSD estimationmethods. Event Detection and waveformanalysis: Identification of heart sounds, Morphological analysis of ECG waves and Activity	8
UNIT-V	Adaptive Filtering: Introduction, General structure, LMS, adaptive noisecancellation in ECG, cancellation of ECG from EMG signal, Cancellation ofmaternal ECG in fetal ECG. EEG: EEG signal characteristics, Sleep EEG classification and epilepsy	8

Text Books/ Reference Material:

1. “Biomedical Signal Analysis” A case study approach, Rangaraj M Rangayyan, JohnWiley publications
2. Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I)”,Arnon Cohen, CRC press.
3. Biomedical Signal Processing Principles and Techniques” D.C.Reddy, Tata Mc Graw-Hill.
4. “Biomedical Digital Signal Processing”, Willis J. Tompkins, PHI.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23006				
Title of theCourse:	Speech Processing				
Designation:	ELECTIVE course.				
Pre-Requisite:	**EC22103**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Recognize the feasibility of applying a soft computing methodology for a particular problem
CO2:	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
CO3:	Apply genetic algorithm to combinational optimization problems.
CO4:	Apply neural networks to pattern classifications and regression problems. And compare solutions by various soft computing approaches for a given problem

Topic Covered:		**Lectures**
UNIT-I	Introduction to fundamentals of digital speech processing: Speech signal, storage,synthesis, speaker verification, identification and recognition, Discrete timessystems, sampling, FIR and IIR Digital Filters	7
UNIT-II	Models of the speech signals: Speech production, acoustic theory, digital modelsof speech signals, Vocal tract, time dependent processing of speech, pitch, speechand silence discrimination.	8
UNIT-III	Digital representation of speech waveform: Sampling speech signal, statisticalspeech models, instantaneous, quantization, adaptive quantization, differentialquantization, delta modulation, differential PCM, and Direct digital codeconversion	8
UNIT-IV	Short Term Fourier Analysis, digital filter banks, spectrographic displays, pitchdetection, Analysis by synthesis system, Homomorphic Speech Processing,Homomorphic systems for convolution, Complex Speech Spectrum, Pitchdetection and formant estimation, homomorphic vocoder	8
UNIT-V	Linear Predictive coding of speech: Linear predictive analysis, Gain computation,Prediction error signal, Frequency domain interpretation, Applications of LPC parameters and speech synthesis.	9

Text Books/ Reference Material:

1. "Digital Processing of Speech Signals", Lawrence Rabiner, Ronald W. Schafer,Macmillan Publishing, 1993.
2. “The Scientist and Engineer‟s Guide to Digital Signal Processing”, Steven W. Smith,California Technical Publishing, 1997.
3. “Discrete-Time Speech Signal Processing – Principles and Practice”, Thomas F Quatieri, Pearson Education, 2004.
4. “Speech Recognition”, Claudio Becchetti and Lucio PrinaRicotti, John Wiley and Sons, 1999.
5. “Speech and Audio Signal Processing, Processing and Perception of Speech and Music”, Ben Gold and Nelson Morgan, Wiley- India Edition, 2006.

PROGRAMME ELECTIVE-2

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23007				
Title of theCourse:	Microcontrollers and Applications				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Know about the evolution of microcontrollers.
CO2:	Acquire knowledge of assembly language programming.
CO3:	Learn the idea of different addressing modes of microcontroller.
CO4:	Discuss serial communication and interfacing with devices.

Topic Covered:		**Lectures**
UNIT-I	The 8051 microcontroller: Evolution of microcontrollers, overview of the 8051 family.	7
UNIT-II	Assembly language programming: Arithmetic, logical, jump, loop, call instructions. Input/Output port programming :pin descriptions of the 8051, I/O programming; bit manipulation	8
UNIT-III	Addressing modes: Immediate and register addressing modes; memory accessing. Timer/Counter programming.	8
UNIT-IV	Serial communication: basics, connection to RS232 and programming. Interrupts: different types and their programming	8
UNIT-V	Real world interfacing: LCD, ADC, Sensors, stepper motors, keyboards	9
Text Books/ Reference Material:	1. The 8051 Microcontroller and Embedded Systems, M. A. Mazidi, and J.G. Mazidi, Pearson Education 2. Microcontroller Projects in C for 8051, D. Ibrahim, New	

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23008				
Title of theCourse:	Computer Organization				
Designation:	ELECTIVE course.				
Pre-Requisite:	**EC22102/EC23101**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	0	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understand the evolution of computer and basic terminology in computer organization

CO2: Understand the concept of memory organization

CO3: Understand the design of central processing unit of computer

CO4: Understand the concept of system organization in computer.

Topic Covered:		**Lectures**
UNIT-I	Concepts and Terminology: Digital computer concepts; Von-Neumann concept; Hardware and Software and their nature; structure and functions of a computer system, Role of operating system Evolution of computer architectures, different generations, CISC and RISC characteristics	8
UNIT-II	Memory Unit: Memory classification, characteristics; static memories, dynamic memories; Organization of RAM, address decoding ROM/PROM/EEPROM; Concept of memory map, memory hierarchy, Associative memory organization; Cache introduction, Replacement algorithms. On chip caches. Performance consideration interleaving. Hit rate, miss penalty. Concept of virtual memory and paging.	10
UNIT-III	Processor organization: The ALU–ALU organization, Integer representation, 1s and 2s complement arithmetic; Serial and Parallel Adder; implementation of high-speed Adder Carry Look Ahead and carry Save Adder; Multiplication of signed binary numbers-Booth's algorithm; Divide Algorithms-Restoring and Non-Restoring. Control Design, Instruction sequencing, Interpretation, Hard wired control-Design methods, and CPU control unit. Microprogrammed Control-Basic concepts, minimizing microinstruction size, multiplier control unit.	12
UNIT-IV	System organization: Input-Output systems, Interrupt, DMA, Standard I/O interfaces Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network. Introduction to Flynn's classification –SISD, SIMD, MISD, MIMD architectures.	10

Text Books/ Reference Material:

1. V. Carl Hammacher, "Computer Organisation", Fifth Edition.
2. A.S. Tanenbum, "Structured Computer Organisation", PHI, Third edition.
3. Y. Chu, "Computer Organization and Microprogramming", II, Englewood Chiffs, N.J., Prentice Hall Edition.
4. M.M. Mano, "Computer System Architecture", Edition.
5. C.W. Gear, "Computer Organization and Programming", McGraw Hill, N.V. Edition.
6. Hayes J.P, "Computer Architecture and Organization", PHI, 2nd edition.

Department:	**Electronics and Communication Engineering**
Course Number:	EC23009
Title of theCourse:	Introduction to Plasmonics
Designation:	ELECTIVE course
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Understand the electromagnetic of metals
CO2:	Understand and analyze the surface Plasmon polariton at single and multilayer system
CO3:	Understand the different concept of excitation technique of surface Plasmon polariton
CO4:	Apply the physics of plasmonics for plasmon waveguide

Topic Covered:		**Lectures**
UNIT-I	ELECTROMAGNETICS OF METALS: Maxwell's Equations and Electromagnetic Wave Propagation, the Dielectric Function of the Free Electron Gas ,The Dispersion of the Free Electron Gas and Volume Plasmons, Real Metals and Interband Transitions The Energy of the Electromagnetic Field in Metals	8
UNIT-II	SURFACE PLASMON POLARITONS AT METAL / INSULATOR INTERFACES: The Wave Equation, Surface Plasmon Polaritons at a Single Interface, Multilayer Systems, Energy Confinement and the Effective Mode Length	7
UNIT-III	EXCITATION OF SURFACE PLASMON POLARITONS AT PLANAR INTERFACES: Excitation upon Charged Particle Impact, Prism Coupling,Grating Coupling, Excitation Using Highly Focused Optical Beams, Near-Field Excitation, Coupling Schemes Suitable for Integration with Conventional Photonic Elements	8
UNIT-IV	ELECTROMAGNETIC SURFACE MODES AT LOW FREQUENCIES Surface Plasmon Polaritons at THz Frequencies , Designer Surface Plasmon Polaritonson Corrugated Surfaces ,Surface Phonon Polaritons	7
UNIT-V	PLASMON WAVEGUIDES Planar Elements for Surface Plasmon Polariton Propagation , Surface Plasmon PolaritonBand Gap Structures, Surface Plasmon Polariton Propagation Along Metal Stripes, Metal Nanowires and Conical Tapers for High-Confinement Guiding and Focusing Localized Modes in Gaps and Grooves	10

Text Books/ Reference Material:

1. S. A. Maier, Plasmonics: Fundamentals and Applications
2. Heinz Raether, "Surface Plasmons on Smooth and Rough Surfaces and on Gratings

Department:	**Electronics and Communication Engineering**				
Couse Number:	**EC23010**				
Title of the Course:	**Embedded Systems**				
Designation:	**ELECTIVE COURSE**				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	**0**	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Distinguish between embedded systems and general systems and understand embedded system design models
CO2:	Understanding embedded I/O and interfacing
CO3:	Design of architectures of embedded processors and communication used in embedded systems
CO4:	Study of embedded software and OS for real time operating systems and their issues

Topic Covered:

UNIT-I	Introduction to Real Time Embedded Systems: Embedded Systems Components, Digital Signal Processors, General Purpose Processors, Embedded Processors and Memory-Interfacing	**Lectures 10**
UNIT-II	Embedded Systems I/O: Interfacing bus, Protocols, Timers, Interrupts, DMA,USB and IrDA, AD and DA Converters, Analog Interfacing	**10**
UNIT-III	Design of Embedded Processors: Field Programmable Gate Arrays and Applications with HDL, Embedded Communications: Serial, Parallel, Network, Wireless Communication	**10**
UNIT-IV	Embedded System Software and Software Engineering issues: Introduction to Real Time Systems, Real-Time Task Scheduling, Concepts in Real-Time Operating Systems, Commercial Real-Time Operating Systems, Introduction to Software Engineering, Requirements Analysis and Specification, Modelling Timing Constraints, Software Design	**10**

Text Books/ Reference Material:

1. Real Time Systems, Rajib Mall, PHI, New Delhi
2. Embedded Systems Architecture - A Comprehensive Guide for Engineers and Programmers, Tammy Noergaard, Newnes, Elsevier
3. An Embedded System Primer, Simon, PHI
4. Embedded Systems-Architecture, Programming and Design, Raj Kamal , TMH
5. "Embedded System Design: A Unified Hardware/Software Introduction", Frank Vahid, Tony D. Givargis, Wiley Publishers.

Department:	**Electronics and Communication Engineering**
Course Number:	EC23011
Title of theCourse:	Transducers and Signal Conditioning
Designation:	ELECTIVE course.
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0		3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Students will know the workings of various transducers
CO2:	Will know applications of active and passive transducers
CO3:	Will know working and applications of the optical transducers
CO4:	Will know signal conditioning circuits for various instruments.

Topic Covered:		**Lectures**
UNIT-I	Introduction: Measurement systems, Basic electronic measuring system, Transduction principles, Classification of transducers, General transducers characteristics, Criteria for transducer selection. Resistive Transducers: Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors.	8
UNIT-II	Inductive Transducers, variable Inductive Transducers, LVDT (Linear variable differential transformer). Capacitive Transducers, Types of capacitive transducer. Elastic Transducers: Spring bellows, diaphragm, bourdon tube – their special features and application.	8
UNIT-III	Active Transducers: Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: Thermocouple, Piezo-electric transducer, Magneto-strictive transducer, Hall effect transducer, Photo-voltaic transducer and Electrochemical transducer.	8
UNIT-IV	Other Transducers: Optical transducers: photo-emissive, photo-conductive and Photo-voltaic cells, Digital Transducers: Optical encoder, Shaft encoder. Feedback fundamentals, introduction to Inverse transducer	8
UNIT-V	Signal Conditioning: Concept of signal conditioning, Introduction to AC/DC Bridges. Op-amp circuits used in instrumentation, Instrumentation amplifiers, analogue-digital sampling, introduction to A/D and D/A conversion, signal filtering, averaging, correlation, Interference, grounding, and shielding.	8

Text Books/ Reference Material:

1. Murty D. V. S., “Transducers & Instrumentation”, PHI, New Delhi (2000)
2. Sawhney A. K., “Electrical and Electronics Measurements and Instrumentation”, Dhanpat Rai and Sons, New Delhi (2000)
3. Kalsi H S, “Electronic Instrumentation “Tata McGraw Hill, New Delhi, 4th Ed. (2001).
4. Patranabis D., “Sensors and Transducers”, PHI, New Delhi (2003).
5. Doebelin Ernest O.,” Measurement Systems: Application and Design”, Tata McGraw Hill Ltd., New Delhi (2004).

Department:	**Electronics and Communication Engineering**				
Course Number:	EC23012				
Title of theCourse:	Digital Image Processing				
Designation:	ELECTIVE course.				
Pre-Requisite:	EC22102/EC22103				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Identify and analyze the fundamental steps in Image processing.

CO2: Characterize the hardware and software components of imaging systems.

CO3: Understand the models and interpret the spatial and frequency domain image processing algorithms and analyze and verify different image recognition techniques.

CO4: Apply the concepts and image processing tools for different image processing and pattern recognition applications.

Topic Covered:		**Lectures**
UNIT-I	Fundamental concepts of digital geometry, Digital image representation, Fundamental steps, Image Processing systems, Image acquisitions, Storage, Communication, Display fundamentals. Visual perception, Simple image model, Sampling and quantization, Basic relationships between pixels neighbour of pixels, Connectivity's, Relation, Equivalence and transitive clause, Distance measures, Arithmetic/logic operations	8
UNIT-II	Imaging Geometry: basic transformations, perspective transformations, Camera models; Photographic films- Film structure and exposure, film Characteristics diaphragm and shutter setting. Introduction to Fourier Transform, the discrete Fourier Transform, properties, separability, translation periodicity and conjugate symmetry, rotation, distributivity, and scaling, average value, Laplacian, convolution, and Correlation sampling, Fast Fourier Transforms, FFT algorithm, Inverse FFT , Implementation	10
UNIT-III	Image enhancement: Spatial domain methods, Frequency domain method, Enhancement by point processing , Simple intensity transforms, Histogram processing, Spatial filtering, Smoothing filters Image restoration : Degradation model, Degradation model for continuous Functions, algebra approach to restoration, Un-constrained restoration, constrained restoration, Removal of blur caused by uniform linear motion, Blind image, Deconvolution, Some algorithms.	8
UNIT-IV	Image coding- Redundancy, Interpixel redundancy, Measuring information, Information channel, Fundamental coding theorem, Image Segmentation , Line detection, Edge detection, Thresholding , Region splitting and merging.	7
UNIT-V	Image compression, Image compression models: The source encoder and decoder, Channel encoder and decoder, Error free compression, Variable length coding, Lossless predictive coding, Lossy compression: Lossy predictive coding, Transformed coding, Synthesis and analysis of image, Recognition, interpretation	7

Text Books/ Reference Materials

1. Digital Image Processing Using Java, Efford, AWL, NY, 2000.
2. The Computer Image, A Watt and F.Policarpo AWL,NY, 1999
3. Fundamentals of Image Processing by A.K. Jain, PHI

PROGRAMME ELECTIVE-3

Department:	**Electronics and Communication Engineering**
Course Number:	EC24001
Title of theCourse:	Multimedia Communication and Networking
Designation:	ELECTIVE Course
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0		**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Students will know the basics of analog and digital video: video representation and transmission and analyze analog and digital video signals and systems

CO2: They will know the fundamental video processing techniques

CO3: They will acquire the basic skill of designing video compression and to familiarize with video compression standards

CO4: To know the basic techniques of video transmission systems, error control and rate control.

Topic Covered:		**Lectures**
UNIT-I	Basics of analog and digital video: colour video formation and specification, analog TV system, video raster, digital video formats. Frequency domain analysis of video signals, spatial and temporal frequency response of the human visual system.	8
UNIT-II	Scene, camera, and motion modelling, 3D motion and projected 2D motion, models for typical camera/object motions.	8
UNIT-III	2D motion estimation: optical flow equation, different motion estimation methods (pel-based, block-based, mesh-based, global motion estimation, multi-resolution approach), Basic compression techniques: information bounds for lossless and lossy source coding, binary encoding, scalar/vector quantization.	8
UNIT-IV	Waveform-based coding: transform coding, predictive coding including motion compensated prediction and interpolation, block-based hybrid video coding, scalable video coding.	8
UNIT-V	Video compression standards (H.261 and H.263, MPEG1, MPEG2, MPEG4, MPEG7). Error control in video communications. Video transport over the Internet and wireless networks.	8

Text Books/ Reference Material:

1. JPEG2000: Image Compression Fundamentals, Standards, and Practice," D. Taubman and M. Marcellin, Kluwer, 2001. ISBN: 079237519X.
2. "H.264 and MPEG-4 Video Compression," Iain E G Richardson, John Wiley & Sons, September 2003, ISBN 0-470-84837-5
3. "Video Coding for Mobile Communications: Efficiency, Complexity and Resilience", M. E. Al-Mualla, C. N. Canagarajah and D. R. Bull, Elsevier Science, Academic Press, 2002. ISBN: 0120530791
4. "Digital Video Processing," A. Murat Tekalp, Prentice Hall, Englewood Cliffs, NJ
5. "Introduction to Data Compression," Khalid Sayood, 2nd ed., Morgan Kaufmann.
6. "Digital Compression for Multimedia: Principles & Standards," Jerry Gibson, Toby Berger, Tom Lookabaugh, Rich Baker and David Lindbergh, Morgan Kaufmann, 1998. ISBN 1-55860-369-7.
7. "Digital Pictures – Representation, Compression and Standards," A. N. Netravali and B. G. Haskell, 2nd ed. Plenum Press, 1995.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24002				
Title of theCourse:	Telecommunication Switching				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Analyze the performance of a digital telephone switch.

CO2: Understand the basics of switching and multiplexing in public and private telephone networks.

CO3: Knowledge on fundamental concepts of network synchronization and able to diagnose and correct the synchronization faults

CO4: Knowledge on designing and modelling of switching systems and understand the standards of ISDN, digital loop carrier systems.

Topic Covered:		**Lectures**
UNIT-I	Telecommunications Transmission- Four-wire circuits, TDM, PCM, Differential coding, Pulse Transmission, Line Coding, Binary N – Zero Substitution, Digital Bi-phase. SONET/SDH: SONET Frame Formats, Operations, Administration and Maintenance, Payload Framing and Frequency Justification, Virtual Tributaries, DS3 & E4 Payload Mapping, SONET Optical Standards, Networks, SONET Rings.	8
UNIT-II	Evolution of switching system, Switching Networks, Digital Switching-Switching Functions, Space Division Switching, Time Division Switching, two-dimensional switching: STS Switching, TST Switching, Signaling techniques- In channel, Common channel signaling, SS7 signaling.	8
UNIT-III	Network Synchronization Control and Management Timing: Timing Recovery, Phase-Locked Loop, Clock Instability, Jitter Measurements, Systematic Jitter. Timing Inaccuracies: Slips, Asynchronous Multiplexing, Network Synchronization, Network Control, Network Management.	8
UNIT-IV	Traffic Characterization: Arrival Distributions, Holding Time Distributions, Loss Systems, And Network Blocking Probabilities: End-to-End Blocking Probabilities, Overflow Traffic, And Delay Systems: Exponential Service Times, Constant Service Times, Finite Queues.	8
UNIT-V	Digital Subscriber Access: ISDN, High-Data-Rate Digital Subscriber Loops, VDSL, Digital Loop Carrier Systems, Fiber in the Loop, Hybrid Fiber Coax Systems, and Voice band Modems, Local microwave Distribution Service, Digital Satellite Services.	8

Text Books/ Reference Material:

1. Telecommunication Switching System and Networks, Viswanathan. T., PHI.
2. Telecommunication transmission systems, Robert G. Winch, 2nd ed. TMH.
3. Digital Telephony, Bellamy John, John Wily & Sons, Inc. 3rd ed. 2000
4. Intro. to Telecommunications, Marion Cole, 2nd ed. Pearson education 2008.
5. Encyclopedia of Networking and telecom., Tom Sheldon, TMH seventh reprint 2006.

Department: **Electronics and Communication Engineering**
Course Number: EC24003
Title of theCourse: Optical Fiber Communication
Designation: ELECTIVEcourse
Pre-Requisite:

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Quantitatively analyze individual components of Optical Fiber Communication link.
CO2: Compute analog and digital optical fiber link design parameters.
CO3: Analyse optical source, Fiber and Detector operational parameters.
CO4: Understand, model and analyze the components of optical networking technology

Topic Covered:		**Lectures**
UNIT-I	Introduction: Advantage over other communication system. Optical wave guides-Ray theory of transmission, Total internal reflection, acceptance angle, Numerical aperture, skews rays.	6
UNIT-II	EM theory of optical propagation. Setup and graded index fibers, Modes and their coupling, single mode fiber, mode field diameter, spot size. Transmission characteristics of optical fiber- Intrinsic and Extrinsic absorption, Linear scattering, Fiber band loss, Material and waveguide dispersion, Intermodal dispersion, Modified single mode fiber.	7
UNIT-III	Optical sources-LASERS: Absorption and emission of radiation, Einstein relation, Population inversion, Optical feedback and threshold condition for laser oscillation. Optical emission from semiconductors- PN Junction, Spontaneous and stimulated emission and lasing. Heterojunctions, semiconductor injection laser, efficiency, Laser modes, Single mode operations, Injection Laser characteristics. LED structure- surface and edge emitters. LED characteristics-Optical output power, output spectrum, Modulation BW	10
UNIT-IV	Optical detectors-Principles, Direct and Indirect absorption, Group 3 to 5 alloy. Quantum efficiency, p-n-p-n, Avalanche and p-i-n photodiode. Receiver structure-Low and high impedance front end.	7
UNIT-V	Optical amplification-Semiconductor Laser and fiber amplifier. Optical TDM, WDM. Transmission link analysis, Point to point links, System considerations, Link power budget, Rise time budget. Fiber attenuation measurements-Opticaltime domainreflecto-meter. Fiber fault location, Dispersion measurements.	10

Text Books/ Reference Material:

1. Optical Fiber Communication: Principles and Practice, 2nd Ed. John Senior, Prentice Hall of India, New Delhi., 1992
2. Optical Fiber Communication, 3rd Ed., G. Keiser, McGraw Hill International, New York, 2000

Department: **Electronics and Communication Engineering**
Course Number: EC24004
Title of theCourse: Wireless Communication
Designation: ELECTIVE course
Pre-Requisite: **EC22202/EC2301**

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Familiarize with various generations of wireless communication systems.
CO2: Familiarize with cellular communication systems.
CO3: Understand the effects of channel encountered in wireless Communication.
CO4: Understand the counter techniques of channel effects.

Topic Covered:		**Lectures**
UNIT-I	Wireless Communication Systems: evolution of mobile radio communications.Radio communication systems: paging systems, cordless telephone systems, cellular telephone systems; comparison of common wireless communications, generations of cellular mobile communication networks. Radio wave propagation, free space propagation model.	7
UNIT-II	Mobile communication: Limitations of conventional mobile system. Cellular communication: introduction, frequency reuse, cluster size, cellular system architecture, mobile station, base station, MSC, channel assignment strategies, call handover strategies, interference and system capacity, improving capacity in cellular systems.	11
UNIT-III	Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Two-Ray model, Fresnel Zone Geometry, Knife edge Diffraction Model, Scattering. Small Scale Fading: Factors, types of small scale fading, Rayleigh and Ricean Distribution.	12
UNIT-IV	Equalization and Diversity: Equalization Fundamentals, Linear and Non Linear Equalizers, Algorithms for Adaptive Equalizers. Diversity techniques: Selection Diversity, Maximal Ratio Combining, Polarization Diversity, Frequency Diversity and Time Diversity. RAKE Receiver.	10

Text Books/ Reference Material:

1. Wireless Communication Principles and Practice, Theodore S Rapaport, Pearson Education.
2. Wireless Communication, Andrea Goldsmith, Cambridge

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24005				
Title of theCourse:	Instrumentation and Process Control				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understand concepts of process dynamics and various forms of mathematical models to express them, including differential equations, Laplace transfer functions, and frequency response plots.

CO2: Develop mathematical models of chemical and processes by writing unsteady-state mass and energy balances.

CO3: Analyse, design and tune feedback / feedforward controllers in the context of various control strategies used to control chemical and biological processes.

CO4: Recognize and fit various simple empirical models that are used for designing controllers.

Topic Covered:		**Lectures**
UNIT-I	Introduction of Process Control: Steady state system, Process control, Feedback control, Transient response, Proportional control, Integral control, Block diagram, Parts of control system,Laplace Transforms.	6
UNIT-II	Response of First Order Systems:Mercury thermometer, Transient response of step functions, Sinusoidal input, Impulse functions. Physical Examples of First Order Systems: Liquid level, Mixing process, RC circuit, linearization. First Order System in Series: Non-interacting system of liquid level, Generalization of several non-interacting systems in series, Interacting systems. Second Order Systems,Development of transfer functions, Damped vibrator, Liquid manometer, Thermometer in thermos- pocket, Step response & impulse response.	8
UNIT-III	The Control Systems Block diagram, Negative and positive feedback, Servo problem v/s regulator problems, Process measuring element, Controller, Final control element. Closed Loop Transfer Functions: Overall transfer function for single loop system, change in load, multi loop control system, Controllers and Final Control Elements, Actual v/s Ideal controller, Pneumatic controller mechanism of proportional control, Proportional integral (PI) control, Proportional derivative (PD) control, Proportional integral derivative (PID) control. Control valve, Control valve characteristics.	10
UNIT-IV	Transfer functions of P, On-off, PI, PD, and PID control Transfer functions of P, On-off, PI, PD, and PID control, Motivation for addition of integral and derivative modes, Block diagram of chemical reactor control system. Transient Response of Control Systems, Method of Root Locus for stability analysis, Nyquist stability criterion.	8
UNIT-V	Frequency Response analysis: Fortunate circumstances, Transportation lag, Bode diagrams, First order system, First order system in series, Graphical rules for Bode diagrams.	8

Text Books/ Reference Material:

1. Stephanopoulos, G.(1984)."Chemical process control: an introduction to theory and practice," Prentice-Hall, New Delhi.
2. Seborg, D.E.,Edgar, T.F. and Mellichamp, D.A.(2003). "Process dynamics and control," Wiley, New York.
3. Smith, C.A. and Corripio,A.B.(1997)."Principles and practice of automatic process control," Wiley, New York
4. Johnson, C.D.(2006)."Process control instrumentation technology," PHI.

Department: **Electronics and Communication Engineering**
Couse Number: **EC 24006**
Title of the Course: Artificial Intelligence and Machine Learning
Designation: **ELECTIVE COURSE**
Pre-Requisite:

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	**0**	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:
CO1: **Learn the fundamentals of machine learning**
CO2: **Learn various AI paradigms**
CO3: **Learn applications of ML and AI**
CO4: **Learn various ML tools**

Topic Covered:

		Lectures
UNIT-I	Introduction to artificial intelligence and machine learning, machine learning examples, well defined machine learning problem, decision tree learning, overfitting, random variables and probabilities, python introduction and essentials, Sklearn tool, keras tool.	**5**
UNIT-II	Bayes rule, maximum likelihood estimation, maximum a priori estimation, conditional independence, naïve Bayes: why and how, gaussian naïve Bayes classifiers, document classification, brain image classification, decision trees. Uniformed search, A* search and heuristics, constrained satisfaction problems, Game trees, adversarial search, expectimax and utilities. DFS and BFS, Alpha-Beta pruning, D-separation, elimination of one variable and variable elimination.	**10**
UNIT-III	Markov decision processes. Logistic regression: maximizing conditional likelihood, gradient ascent as a general learning/optimization problem. Generative/discriminative models, minimizing squared error and maximizing data likelihood, regularization, bias-variance decomposition. Learning theory, graphical models, EM and clustering.	**10**
UNIT-IV	Reinforcement learning, markov models, Hidden Markov Models, (HMM) applications of HMMs/speech, sampling, Laplace smoothing. Geometric margins and perceptrons. Kernels, SVM. Partial clustering, hierarchical clustering, learning representations, dimensionality reduction.	**8**
UNIT-V	Neural networks, Deep learning concepts, natural language processing, games, robotic cars, computer vision and robotics.	**7**

Text Books/ Reference Material:

1. Artificial Intelligence: A Modern Approach, S. Russell and P. Norvig, Prentice Hall, ISBN0-13-080302-2
2. Learning From Data, Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien-Lin, AMLBook, ISBN-10: 1600490069.
3. Machine Learning, Tom Mitchell, McGraw Hill, ISBN 0070428077.

PROGRAMME ELECTIVE-4

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24007				
Title of theCourse:	Advanced Digital System Design				
Designation:	ELECTIVE course.				
Pre-Requisite:	**EC23101**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understand the fundamentals of various Combinational and Sequential logic design techniques and theorems.

CO2: Learn the Basics of VHDL modeling and design techniques.

CO3: Understand the basic concepts of Programmable Logic Devices and Design of statemachine using Algorithmic State Machines chart.

CO4: Understand about various types of FPGA, Xilinx series, and Design examples.

Topic Covered:		**Lectures**
UNIT-I	Revision of basic Digital systems: Combinational Circuits, Sequential Circuits, Timing, Electrical Characteristics., Power Dissipation.	6
UNIT-II	VHDL for Synthesis: Introduction, Behavioral, Data flow, Structural Models, Simulation, Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Packages, Functions, Procedures, Operator Inferencing, Test bench.	8
UNIT-III	Digital system Design: Top down Approach to Design, Case study, Data Path, Control Path, Controller behavior and Design, Case study Mealy & Moore Machines, Timing of sequential circuits, Pipelining, Resource sharing, FSM issues	10
UNIT-IV	Programmable Logic Devices: Introduction, Evolution: PROM, PLA, PAL, Architecture of PAL's, Applications, Programming PLD's, Design Flow, Programmable Interconnections, Complex PLD's (MAX - 7000, APEX), Architecture, Resources, Applications.	8
UNIT-V	FPGA's: Introduction, Logic Block Architecture, Routing Architecture, Programmable, Interconnections, Design Flow, Xilinx Virtex-II (Architecture), Boundary Scan, Programming FPGA's, Constraint Editor, Static Timing, Analysis, One hot encoding, Applications, Tools, Case Study, Xilinx Virtex II Pro, Embedded System on Programmable Chip, Hardware-software co-simulation, Bus function models, BFM Simulation, Debugging FPGA Design, Chip scope Pro.	8

Text Books/ Reference Material:

1. Digital Design: Principles and Practices, Jon F Wakerly, Prentice Hall.
2. VHDL for programmable logic, Kevin Skahil, Addison Wesley.
3. VHD: analysis and modelling of digital systems, ZainalabedinNavabi, Me Graw-Hill
4. PLD, FPGA data sheet

Department: **Electronics and Communication Engineering**
Course Number: EC24008
Title of theCourse: Semiconductor Devices Modelling
Designation: ELECTIVE course.
Pre-Requisite: EC23203

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Calculate carrier distributions in thermal equilibrium and non-thermal equilibrium conditions for intrinsic and doped semiconductors,

CO2: Apply basic semiconductor drift-diffusion equations and continuity of Fermi energy to determine current flow in semiconductor devices,

CO3: Determine alignment of metal-semiconductor band diagrams and identify whether a junction is Ohmic or Schottky

CO4: Design a BJT and MOSFET that meets specific performance criteria.

Topic Covered:		**Lectures**
UNIT-I	Energy bands in 3D crystals, Density of States, Fermi-Dirac Statistics, Doping, Equilibrium Statistics, Equilibrium Concentration. Recombination-Generation, Bulk Recombination, Surface Recombination/Generation.	7
UNIT-II	Carrier Transport, Hall effect, Drift, Diffusion, Continuity Equation, Numerical Solution of Transport Equation.	8
UNIT-III	Electrostatics of P-N Junction Diodes, P-N Diode I-V Characteristics, Fermi Level Differences for Metals and Semiconductors, Schottky Diode I, Schottky Diode II, Non-ideal Effects, ac response, large signal response.	10
UNIT-IV	Introduction to Bipolar Junction Transistor, BJT design, Heterojunction BJT	8
UNIT-V	MOSFET Electrostatics, MOS capacitor frequency response, MOSFET IV characteristics, Non-ideal effects in MOSFET, Modern MOSFET. Reliability of MOSFET	7

Text Books/ Reference Material:

1. “Advanced Semiconductor Fundamentals”, Robert F Pierret, Pearson Education, Volume VI Modular Series on Semiconductor Devices
2. “Semiconductor Device Fundamentals”, Robert F Pierret, Pearson Education, Volume I Modular Series on Semiconductor Devices
3. “Operation and Modeling of the MOS Transistor”, Tsividis, Y,Oxford University Press.
4. Fundamentals of Modern VLSI Devices, Taur and Ning, Cambridge Press, 1999.
5. “Physics of Semiconductor Devices,” S. M. Sze and K. K. Ng, 3rd Edition, Wiley-Interscience.
6. Introduction to Solid State Physics, C. Kittle, 7th Edition, Wiley.Compound Semiconductor Device Physics, S S. Tiwari, Academic Press, 1991

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24009				
Title of theCourse:	Advanced Computer Architecture				
Designation:	ELECTIVE course				
Pre-Requisite:	EC23008				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Study the architectures and elements of computer and basic classification of parallel processing

CO2: Study the different types of data processor arithmetic circuit of CPU and control unit Design

CO3: Understand memory hierarchies used in computer and information flow in computers

CO4: Understand the basic idea of parallel processing and parallel computing.

Topic Covered:		**Lectures**
UNIT-I	Introduction: review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. Evolution of computer architectures, different generations. CISC and RISC processors, Flynn's Classification	6
UNIT-II	CPU Design: ALU organization , Serial and Parallel Adder, implementation of high speed Adder Carry Look Ahead and carry Save Adder; Multiplication of signed binary numbers-Booth’s algorithm, Divide algorithms- Restoring and Non-Restoring, Floating point number arithmetic, Hardwired control, Micro-programmed control, practical aspects of circuit implementations.	10
UNIT-III	Hierarchical memory technology: Inclusion, Coherence and locality properties. Cache memoryorganizations, Techniques for reducing cache misses, Virtual memory organization, mapping and management techniques, memory replacement policies.	8
UNIT-IV	Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling, Pipeline optimization techniques, Compiler techniques for improving performance.	6
UNIT-V	Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, super pipelined and VLIW processor architectures, Array and Vector processors	10

Text Books/ Reference Material:

1. Computer Organization, Carl Hamacher, ZvonkoVranesic, SafwatZaky, Mc Graw Hill International
2. Computer Architecture and Organization, J.P. Hayes Mc Graw Hill International
3. Advanced Computer Architecture, Kai Hwang, McGraw Hill International.
4. Computer Organization and Architecture, William Stallings, Macmillan Publishing Company.
5. Designing Efficient Algorithms for Parallel Computers, M.J. Quinn, McGraw Hill International

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24010				
Title of the Course:	Nano electronics.				
Designation:	ELECTIVE course				
Pre-Requisite:	EC23203				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: To explain challenges due to scaling on CMOS devices, VLSI circuit design and fundamental limits of operation.

CO2: To analyse and explain working of novel MOS based silicon devices and various multi gate devices

CO3: To analyse and explain working of SOI devices and their performance comparison with Silicon devices.

CO4: To understand Nano electronic systems and building blocks such as: low-dimensional semiconductors, hetero structures, carbon nanotubes, quantum dots, nanowires etc

Topic Covered:		**Lectures**
UNIT-I	Challenges going to sub- 100 nm MOSFETs -Oxide layer thickness, tunnelling, power density, non-uniform dopant concentration, threshold voltage scaling, lithography, hot electron effects, subthreshold current, velocity saturation, interconnect issues, fundamental limits for MOS operation. High-K gate dielectrics, effects of high- K gate dielectrics on MOSFET performance.	8
UNIT-II	Novel MOS- based devices – Multiple gate MOSFETs, Silicon-on-nothing, Silicon-on-insulator devices, FD SOI, PD SOI, Fin-FETs, vertical MOSFETs, strained Si devices.	7
UNIT-III	Hetero structure-based devices –Type I, II and III Heterojunction, Si-Ge hetero-structure, hetero structures of III - V and II-VI compounds -resonant tunnelling devices, MODFET/HEM.	7
UNIT-IV	Carbon nanotubes-based devices –CNFET, characteristics, Spin-based devices –spin FET, characteristics.	8
UNIT-V	Quantum structures –quantum wells, quantum wires and quantum dots, Single electron devices –charge quantization, energy quantization, Coulomb blockade, Coulomb staircase, Bloch oscillations.	10

Text Books/ Reference Material:

1. Nanoelectronics – Principles & devices, Mircea Dragoman and Daniela Dragoman.
2. Nanoelectronics and Nano systems, Karl Goser.
3. Nanoscale Transistors, Device Physics, Modelling and Simulation: Mark Lundstrom and Jing Guo.
4. Physics of Quantum Well Devices, Springer 2002, B.R. Nag

Department:	**Electronics and Communication Engineering**
Course Number:	EC24011
Title of theCourse:	Low Power VLSI Design
Designation:	ELECTIVE course
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	To understand the need for low power CMOS design and power analysis
CO2:	To gain knowledge on low power circuit design styles for VLSI circuits.
CO3:	Study the advanced technique of low power VLSI circuit.
CO4:	Study of low power VLSI circuit from architecture point of view

Topic Covered:		**Lectures**
UNIT-I	Introduction: Introduction to low power VLSI design-Need for low power-CMOS leakage current-static current- Basic principles of low power design-probabilistic power analysis-random logic signal-probability and frequency-power analysis techniques- signal entropy	10
UNIT-II	Circuit level and logic level design: Circuit - transistor and gate sizing; pin ordering, network restructuring and reorganization, adjustable threshold voltages; logic-signal gating; logic encoding.	10
UNIT-III	Special low power VLSI design techniques: Power reduction in clock networks – CMOS floating node - low power bus - delay balancing, Low power technique for SRAM, Adiabatic computation, Pass transistor	10
UNIT-IV	Architecture and System: Power and performance management, Switching activity reduction, Parallel architecture with voltage reduction.	10

Text Books/ Reference Material:

1. Practical Low Power Digital VLSI Design, Gary Yeap, Springer US, Kluwer Academic Publishers.
2. Low power CMOS VLSI circuit design, Kaushik Roy, Sharat C. Prasad, Wiley
3. Low Voltage Low Power VLSI Subsystems, Kiat-Seng Yeo, Kaushik Roy, Tata Mc-Graw Hill.
4. Basic VLSI Design, Douglas A.Pucknell& Kamran Eshraghian, 3 rd edition, PHI.
5. Digital Integrated circuits, J.Rabaey, PH.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24012				
Title of theCourse:	Advanced Digital Signal Processing.				
Designation:	ELECTIVE course				
Pre-Requisite:	EC23102				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Study the concepts of discrete time systems, and design FIR and IIR filters.

CO2: Understand properties of Hilbert transform for a discrete time system.

CO3: Study Cepstrum analysis and Homomorphic Deconvolution and use its characteristics in speech processing.

CO4: Understand multirate DSP, alteration systems, Nyquist filters, wavelet transform, adaptive filters and different algorithms related to it like LMS and RLS algorithms.

Topic Covered:		**Lectures**
UNIT-I	Review: Discrete-Time Signals and Systems, Sampling, Z-transform, DFT, Filter design techniques- FIR, IIR.	8
UNIT-II	Discrete Hilbert transforms: Real and Imaginary Part, sufficiency of the FT for causal Sequences, Sufficiency Theorems for Finite length Sequences, Relationship between Magnitude and Phase, HT Relation for complex sequences.	8
UNIT-III	Cepstrum analysis and Homomorphic Deconvolution: Definition of complex cepstrum Homomorphic Deconvolution, Properties of complex Logarithm, Alternative expression for complex cepstrum, The complex cepstrum of exponential sequences, Realization of the Characteristic system, Examples of Homomorphic Filtering, Application to speech processing.	7
UNIT-IV	Multirate DSP: The basic sample rate Alteration device Filters in sampler rate Alteration System, Multistage Design of Decimator and interpolator. The polyphase Decomposition, Arbitrary rate sampler rate converter, Digital filter banks, Nyquist filters, two channel quadrature mirror filter bank, L channel QMF banks, Cosine modulated L- channel filter banks, Multilevel filter bank, STFT, Wavelet transform, DCT.	10
UNIT-V	Adaptive filters: Introduction, Examples of Adaptive filtering, The minimum mean Square Error Criterion, The windrow LMS algorithm, Recursive Least Square Algorithm, Forward and Backward Lattice method, Gradient adaptive Lattice method.	7

Text Books/ Reference Material:

1. Digital Signal Processing: A Practical approach, Emmanual C. Ifeachor et. Al., Pearson Education, 2nd edition
2. Digital Signal Processing, Algorithms and Applications 3rd edition, Proakis and Manolakis,Prentice Hall of India, New Delhi, 1999.
3. Digital Signal Processing, A Computer based Approach, 2nd edition, S.K.Mitra, Tata McGraw Hill, New Delhi, 2001.
4. Theory and Application of Digital Signal Processing., L.R. Rabiner and B.Gold, PHI
5. Adaptive Filters, Simon Haykin, PHI

PROGRAMME ELECTIVE-5

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24013				
Title of the Course:	Artificial Neural network and its Applications				
Designation:	ELECTIVE course.				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	**0**	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.

CO2: Understand the concepts and techniques of neural networks through the study of important neural network models.

CO3: To evaluate whether neural networks are appropriate to a particular application.

CO4: Apply neural networks to particular application and Analyze the steps needed to improve performance of the selected neural network.

Topic Covered:		**Lectures**
UNIT-I	Introduction: Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks	8
UNIT-II	Support Vector Machines and Radial Basis Function: Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition	8
UNIT-III	Attractor Neural Networks: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.	12
UNIT-IV	Self-organization Feature Map: Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self-organization Feature Maps, Application of SOM, Growing Neural Gas.	10

Text Books/ Reference Material:

1. Neural Networks A Classroom Approach– Satish Kumar, McGraw Hill Education (India) Pvt. Ltd, Second Edition.
2. Introduction to Artificial Neural Systems-J.M. Zurada, Jaico Publications.
3. Artificial Neural Networks-B. Yegnanarayana, PHI, New Delhi 1998.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24014				
Title of the Course:	Modern Digital Communication Techniques				
Designation:	ELECTIVE course				
Pre-Requisite:	**EC23201**				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Interpret and understand the building blocks of a typical digital communication

CO2: Compute probability of error and hence the inter symbol interference from eye diagram.

CO3: Derive expressions for the power spectrum of digital modulated signals.

CO4: Design an encoder and decoder for a typical error control coding scheme.

Topic Covered:		**Lectures**
UNIT-I	Review of sampling theorem, PAM, PPM, PDM and PCM System,TDM and FDM systems and their comparison. Cross talk andguard times. Practical sampling and aliasing. Baseband digital transmission:digital PAM signals, transmission limitations. Power spectra and digital PAM,spectral shaping by precoding. Signal coding Techniques, PCM Generation andReconstruction, Quantization Noise, Non uniform Quantization and companding. DPCM, DM, ADM and ADPCM; Linear Predictive Coding. Transmission ofbase band signal over Band Limited system-RZ and NRZ format.	10
UNIT-II	Matched filter, Error rate due to Noise, ISI, Nyquist criteria for distortionless baseband binary transmission, Optimum Linear Receiver, Adaptive Equalization.	7
UNIT-III	Geometric representation of signals - Gram-Schmidt Orthogonalisationprocedure, Vector Noise Channel, Likelihood functions, Maximum Likelihooddecoding, Correlation receiver, Probability of Error, Frame patterns, Bit andFrame synchronization carrier recovery.	7
UNIT-IV	Introduction to Information Theory-Definition of information, Self and Mutualinformation, Entropy and Information rate. Discrete memoryless source andcoding, Discrete channel capacity, Shannon-Hartley equation for channelcapacity, Markov chains. Principles of Error Detection and Correction methods, Channel Coding - Linear Block Codes, Cyclic Codes, Convolution Coding,Automatic request for retransmission systems.	8
UNIT-V	Digital CW Modulation-Principles, Block schematics and Comparative Study ofASK, FSK and PSK systems, Introduction to Quadrature Carrier and M-arysystems, Modems and standards, Modern Digital Communication Technologies- ISDN, BISDN etc. Cellular digital Radio, Spread Spectrum techniques andPersonal communication Networks.	8

Text Books/ Reference Material:

1. Digital Communications, Simon Haykin John Wiley and Sons.
2. Digital Communications, Proakis , McGraw Hill.
3. Communication Systems, A. B. Carlson, McGraw Hill.

Department: **Electronics and Communication Engineering**
Course Number: EC24015
Title of the Course: Satellite Communication
Designation: ELECTIVE course
Pre-Requisite:

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Acquire knowledge on orbital mechanics of satellite communication systems.
CO2: Understand the satellite segments.
CO3: Have an in-depth knowledge on earth segments, link design and impairments on it.
CO4: Understand the concept of analog and digital technologies used for satellite communication networks with applications.

Topic Covered:		**Lectures**
UNIT-I	Orbital mechanics: Orbital perturbations, Azimuth & elevation angle calculations, limits of visibility, eclipse, sun-transit outage, launches and launch vehicle.	8
UNIT-II	Spacecraft systems: Attitude and Orbit control system, Telemetry, tracking and command (TT&C), communications subsystems, Transponders, Spacecraft antennas.	8
UNIT-III	Earth Segments: Earth station antennas, Amplifiers, Converters, Reliability, Basic transmission theory of satellite link, noise figure and noise temperature, satellite uplink and down link analysis, Propagation on Satellite-Earth Paths and its Influence.	10
UNIT-IV	Satellite Access and Applications: Analog telephone transmission, FM theory, FM Detector theory, analog TV transmission, Digital transmission- base band and band pass transmission of digital data, BPSK, QPSK, PCM, Access techniques: FDMA, TDMA, CDMA, Encoding & FEC for Digital satellite links.	12

Text Books/ Reference Material:

1. Satellite communication, Timothy Pratt, Charles W. Bostian, John Wiley & sons, Publication, 2003 .
2. Digital Satellite Communications, Tri T. Ha, 2nd Edition, Tata McGraw Hill
3. Satellite Communication, Dennis Roddy, 4th Edition, Mc Graw Hill International, 2006
4. Satellite Communication Systems Engineering, Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, Prentice Hall/Pearson, 2007
5. The Satellite Communication Applications, Bruce R. Elbert, Hand Book, Artech House Bostan London, 1997.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24016				
Title of the Course:	**Computer Communication and Network**				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Acquire knowledge on data communication and basic concept of networking.

CO2: Understand the concept of transmission media and Ethernet.

CO3: Design a network for a particular application.

CO4: Understand to Analyse the performance of the networks with applications.

Topic Covered:		**Lectures**
UNIT-I	Review of data communication techniques, basic networking concepts, layered network and protocol concepts, quality of service, Network structure , protocol Hierarchies, The OSI reference model, Service Primitives, Example Networks : ARPANET, SNA etc.	8
UNIT-II	The Physical Layer: Transmission Media, Transmission and Switching, Terminal, The medium Access sub layer, The ALOHA protocols, LAN Protocols, Ethernet, Token bus, Token ring.	8
UNIT-III	The Data link layer: Design issues, Error control, Sliding Window Protocols, protocols performance. The Network layer: Design issues, Routing algorithms, congestion control Algorithms, Internet working.	10
UNIT-IV	The Transport layer: Design issues, connection management. The Session layer: Design issues, Remote procedure call. The Presentation layer: Design issues, data compression techniques concepts, Introduction to Cryptography. The Application layer: Design issues, File transfer, Access and management, Virtual terminals.	12

Text Books/ Reference Material:

1. Computer networks, 3rd Ed., A.S Tanenbaum, Prentice Hall of India, New Delhi. 2001.
2. Data communications, Computer Networks, and Open Systems, 4th Ed, Fred Halsall, Addison Wesely Longman , Singapore 1995.
3. Data and Computer communications, 5th Ed W.Stallings, Prentice Hall of India, New Delhi.2001.
4. Forouzen, “Data Communication and Networking”, TMH

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24017				
Title of the Course:	Wireless Sensor Networks.				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Understanding of various aspects of wireless sensor networks, describe the concepts, implementation, and use of wireless sensor networks.
CO2:	Discuss the challenges in designing MAC, routing and transport.
CO3:	Describe protocols for wireless ad-hoc/sensor networks
CO4:	Describe and implement protocols on a sensor testbed network and propose, implement, and evaluate new ideas for solving wireless sensor network design issues.

Topic Covered:		**Lectures**
UNIT-I	Introduction: Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture, Hardware components, Energy consumption of sensor nodes, Network architecture, Sensor network scenarios, Design principles. Physical Layer: Introduction, wireless channel and communication fundamentals, physical layer and transceiver design consideration in wireless sensor networks, Example physical Layers Bluetooth, IEEE 802.11b, WINS, µAMPS	10
UNIT-II	Data Link Layer: MAC protocols –fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, LEACH, Link Layer protocols, Error control, Framing.	8
UNIT-III	Network Layer: Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, mobile nodes, Data centric and content-based networking, Data aggregation	8
UNIT-IV	Applications: Target detection tracking, Habitat monitoring, Military battlefield awareness Environmental disaster monitoring, Underwater Acoustic and Deep space networks, Wireless Body Area Networks (WBAN) for health-monitoring, Open issues and Design challenges.	7
UNIT-V	Case Study: Security in Sensor networks, Localization, IEEE 802.15.4 low rate WPAN, Practical implementation issues, Sensor Node Hardware- Node-level software platforms, Node-level simulators.	7

Text Books/ Reference Material:

1. Protocol and Architecture for Wireless Sensor Networks, Holger Karl, Andreas willig, John wiley publication, Oct 2007
2. Wireless Sensor Networks: an information processing approach, Feng Zhao, Leonidas Guibas, Elsivierpublication, 2004.
3. Wireless Sensor Networks : Architecture and Protocol, Edgar H. Callaway, CRC press 2003 First Edition.
4. Wireless Sensor Networks, C S Raghavendra Krishna, M Sivalingam and TaribZnati, Springer publication, 2006

Department:	**Electronics and Communication Engineering**
Course Number:	EC24018
Title of the Course:	Radio Frequency Components and Circuits
Designation:	ELECTIVE course
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	understand transmission lines, waveguide and use of smith chart
CO2:	Understand S-matrix and signal flow graph for analysis of microwave network
CO3:	Learn the design of RF-Filters
CO4:	Learn the design of RF Amplifier and Oscillators

Topic Covered:		**Lectures**
UNIT-I	Transmission lines, Waveguides, Microstrip line, Smith chart	10
UNIT-II	Network analysis using S-matrix, Signal Flow graph, RF components: coupler, divider etc. Resonators	10
UNIT-III	RF Filters: Filter design Transformation, Implementations	10
UNIT-IV	Microwave Amplifier and Oscillators: Two-Port Power Gains, Amplifier Stability, Amplifier Design, Broadband Amplifier Design One Port negative resistance oscillators, Two Ports negative resistance oscillators, Oscillator configurations	10

Text Books/ Reference Material:

1. Lumped Elements for RF and Microwave Circuits " I. J. Bahl ,Artech House
2. Microwave Transistor Amplifier: Analysis and Design, Gonzalez G. Prentice Hall 1984.
3. Microwave Semiconductor Circuit Design, Davis W. Alan, Van NostrandReinhold, 1984.
4. Microwave Circuit Analysis and Amplifier Design, Samuel Y. Liao, Prentice Hall 1987.
5. High Frequency Amplifier, Ralph S. Carson, Wiley Interscience, 1982

PROGRAMME ELECTIVE-6

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24019				
Title of the Course:	Analog Integrated Circuits				
Designation:	ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0		3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Students will Know the working of single stage CG, CS, CD amplifiers
CO2:	Know the working of differential amplifier and IC biasing techniques
CO3:	Know the working of OTA, op-amp and different types of noise
CO4:	Analyze basic operation of PLL and VCO.

Topic Covered:		**Lectures**
UNIT-I	Basic MOS Device Physics; MOS device models; Single State Amplifier: Common Source Stage; Source Follower; Common Gate Stage; Cascode Stage	7
UNIT-II	Differential Amplifier: Basic Differential Pair; Common-Mode Response; Differential Pair with MOS Loads; Gilbert Cell; Passive and Active Current Mirrors: Cascode Current Mirrors; Current sink and current source design, Active Current Mirror; Signal Analysis; Frequency Response of Amplifier;	10
UNIT-III	Operational Amplifier: Single-stage and Two stage OTA and Op-amp; Stability and Frequency Compensation; Voltage and Current references, Bandgap References; Introduction to Switched-Capacitor Circuits; Nonlinear and Mismatch	8
UNIT-IV	Noise: Statistical Characteristics of Noise; Types of Noise; Thermal and Flicker noise in CMOS, Representation of Noise in Circuits; Noise in Single-stage Amplifier. Noise analysis of Current Mirror load OTA.	8
UNIT-V	Oscillators: Ring, LC, VCO. Phase-Lock Loop: Charge-Pump PLL, Non-ideal effect in PLL; Delay Locked Loops. Short-Channel effects and Device Models.	7

Text Books/ Reference Material:

1. Design of Analog CMOS Integrated Circuits, B. Razavi, McGraw-Hill Science.
2. Analysis and Design of Analog Integrated Circuits, P. Gray, P. Hurst, S. Lewis, and R. Meyer, 5th Edition, Wiley.
3. Analog Integrated Circuit Design, T. Carusone, D. Johns and K. Martin, 4th Edition, Wiley.
4. CMOS Analog Circuit Design, Phillip E. Allen, Douglas R. Holberg , Oxford
5. Design of CMOS Operational Amplifiers,RasoulDehghani, (Artech House, Norwood, 2013.

Department: **Electronics and Communication Engineering**
Course Number: EC24020
Title of the Course: Digital Integrated Circuits
Designation: ELECTIVE course
Pre-Requisite: **EC24102**

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Assess the quality metrics of a digital design and understand the impact of technology scaling.

CO2: Know how to determine the VTC of a CMOS inverter and compute its noise margins and design a CMOS inverter that meets certain delay and power specifications

CO3: Know how to analyze and design complex logic gates in standard CMOS technology, and compute their delay and power consumption and know the method of logical effort. How to design arithmetic circuits.

CO4: Be able to analyze and design static sequential circuits and understand basic clocking issues and integrity.

Topic Covered:		**Lectures**
UNIT-I	Challenges in Digital IC Design, MOS device model with Sub-micron effects, VTC parameters DC characteristics.	7
UNIT-II	CMOS INVERTER: CMOS Propagation Delay, Parasitic Capacitance Estimation, Layout of an Inverter, Supply and Threshold Voltage Scaling, Components of Energy and Power Switching, Short-Circuit and Leakage Components SPICE Simulation Techniques	7
UNIT-III	COMBINATIONAL LOGIC: Pass Transistor / Transmission Gate Logic DCVSL, Introduction to Dynamic Logic, Dynamic Logic Design Considerations Power Dissipation in CMOS, Leakage Power Dissipation, Logical Effort Sizing – Performance Optimization of Digital Circuits ARITHMETIC STRUCTURES: Adders, Multipliers, Shifters, Design Methodology, Layout Techniques and Mapping	10
UNIT-IV	SEQUENTIAL CIRCUIT: Classification / Parameters Static Latches and Register, Race Condition, Dynamic Latches and Registers, Two Phase vs. Single Phase, Pulse Based Registers, Latch vs. Register Systems, Metastability	8
UNIT-V	INTERCONNECT: Capacitance Estimation, Buffer Chains, Low Swing Drivers, Power Distribution, Issues in Timing - Impact of Clock Skew and Jitter CLOCK DISTRIBUTION: Origins of Clock Skew / Jitter and Impact on Performance, Clock Distribution Techniques, Self-timed Circuits	8

Text Books/ Reference Material:

1. Digital Integrated Circuits - A Design Perspective, Jan M Rabaey, Prentice Hall.
2. CMOS Digital Integrated Circuits - Analysis & Design, Sung-Mo Kang & Yusuf Leblebici, Mc Graw Hill.
3. CMOS Dircuit Design, Layout, and Simulation, R. J. Baker, H. W. Li, and D. E. Boyce, Wiley-IEEE Press, 2007.
4. Analysis and Design of Digital Integrated Circuits, David A. Hodges, Horace G. Jackson, and Resve A. Saleh, Mc Graw-Hill.

Department: **Electronics and Communication Engineering**
Course Number: EC24021
Title of the Course: Computer Aided Design of VLSI Circuits.
Designation: ELECTIVE course
Pre-Requisite: EC24102

Course Details:

Lectures	Tutorial	Practical	Contact Hours	Credits
3	0	0	3	3

Course Assessment Methods:

Theory:		
	Assignments & Quiz:	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: To analyse various physical design methods in VLSI.
CO2: To understand the concepts behind the VLSI design rules and routing techniques.
CO3: To use the simulation techniques at various levels in VLSI design flow.
CO4: To understand the concepts of various algorithms used for floor planning and routing techniques.

Topic Covered:

		Lectures
UNIT-I	Introduction to VLSI Methodologies - VLSI Physical Design Automation - Design and Fabrication of VLSI Devices - Fabrication process and its impact on Physical Design.	8
UNIT-II	A Quick Tour of VLSI Design Automation Tools - Data structures and Basic Alogrithms– Algorithmic Graph theory and computational complexity - Tractable and Intractable problems.	8
UNIT-III	General purpose methods for combinational optimization, partitioning, floor planning and pin assignment, placement and routing.	8
UNIT-IV	Simulation: Gate-level modelling and simulation; Switch-level modeling and simulation, Combinational Logic Synthesis: Binary Decision Diagrams, Two Level Logic Synthesis.	8
UNIT-V	Physical Design Automation of FPGAs, MCMS, High level Synthesis: Hardware models, Internal representation, Allocation, assignment and scheduling, Simple scheduling algorithm, Assignment problem, High level transformations.	8

Text Books/ Reference Material:

1. Algorithms for VLSI Design Automation, S.H. Gerez, John Wiley & Sons, 2002.
2.Algorithms for VLSI Physical Design Automation, N.A. Sherwani, Kluwer Academic Publishers,2002.
3.VLSI Physical Design automation: Theory and Practice, Sadiq M. Sait, Habib Youssef, Worldscientific 1999.
4.Computer Aids for VLSI Design, Steven M.Rubin, Addison Wesley Publishing 1987.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24022				
Title of the Course:	VLSI Digital Signal Processing Systems				
Designation:	ELECTIVE course				
Pre-Requisite:	EC23102/EC24102				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: learn various transforms and its corresponding architectures

CO2: acquire the knowledge of effect of round off noise computation

CO3: design Bit level arithmetic Architectures and optimize the implementation of FIR filters and constant multipliers

CO4: design basic arithmetic units and realize their architecture for higher radices and learndifferent numerical strength reduction techniques

Topic Covered:		**Lectures**
UNIT-I	Algorithms for fast convolution, Algorithmic strength reduction in filters and transforms:Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-Order Filters.	8
UNIT-II	Scaling and Round off Noise - State variable description of digital filters, Scaling andRound off Noise computation, round off Noise in Pipelined IIR Filters, Round off NoiseComputation using state variable description, Slow-down, Retiming and Pipelining.	8
UNIT-III	Bit level arithmetic Architectures- parallel multipliers, interleaved floor-plan and bit-plane-based digital filters, Bit serial multipliers, Bit serial filter design and implementation,Canonic signed digit arithmetic, Distributed arithmetic.	8
UNIT-IV	Redundant arithmetic -Redundant number representations carry free radix-2 additionand subtraction, Hybrid radix-4 addition, Radix-2 hybrid redundant multiplicationarchitectures, data format conversion, Redundant to Non-redundant converter.	8
UNIT-V	Numerical Strength Reduction - Subexpression Multiplication, Subexpression Sharing in Digital Filters, Additive and Multiplicative Number Splitting.	8

Text Books/ Reference Material:

1. "VLSI Digital Signal Processing Systems", K.K. Parhi, John-Wiley.
2. Digital Signal Processing with FPGAs, U. Meyer -Baese, Springer.
3. Digital signal processing in VLSI, Richard J. Higgins.
4. VLSI Design Methodologies for Digital Signal Processing, Magdy A. Bayoumi.
5. VLSI and modern signal processing, Sun Yuan Kung, Harper J. Whitehouse.

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24023				
Title of the Course:	**CMOS Mixed Signal Circuits**				
Designation:	ELECTIVE course				
Pre-Requisite:	EC23102/EC24102				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understand the practical situations where mixed signal analysis is required.

CO2: Analyse and handle the inter-conversions between signals.

CO3: Design systems involving mixed signals.

CO4: Understand the concept of PLL.

Topic Covered:Lectures

UNIT-I	Analog and discrete-time signal processing, introduction to sampling theory; S.N.R. derivation, Analog continuous-time RC-filters: State variable biquadratic filters, Basics of analog discrete-time filters and Z-transforms.	8
UNIT-II	Switched-capacitor (SC) filters- Nonidealities in switched-capacitor filters; Stray-capacitance insensitive SC-networks, Switched-capacitor filter architectures; Switched-capacitor filter applications.	8
UNIT-III	Basics of Data Converters; Nyquist rate converters, Successive approximation ADCs, Dual slope ADCs,Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs, Charge scaling DACs, Pipeline DACs.	8
UNIT-IV	Mixed-signal layout, Oversampling Converters: O.S.R., Zeroth and multiple-order Noise shaping modulators, Decimating filters and interpolating filters, Higher order modulators, Delta sigma modulators with multi-bit quantizers, Delta sigma D/A converter.	8
UNIT-V	Introduction to frequency synthesizers and synchronization; Basics of PLL,Analog PLLs; Digital PLLs; DLLs.	8

Text Books/ Reference Material:

1. CMOS mixed-signal circuit design, R. Jacob Baker, Wiley India, IEEE press, reprint 2008.
2. Design of analog CMOS integrated circuits, Behzad Razavi, McGraw-Hill, 2003.
3. CMOS circuit design, layout and simulation,R. Jacob Baker Revised second edition, IEEE press, 2008.
4. CMOS Integrated ADCs and DACs, Rudy V. dePlassche, Springer, Indian edition, 2005.
5. Electronic Filter Design Handbook, Arthur B. Williams, McGraw-Hill, 1981.
6. Design of analog filters by, R. Schauman, Prentice-Hall 1990 (or newer additions).
7. An introduction to mixed-signal IC test and measurement by,M. Burns et al., Oxford university press, first Indian edition, 2008

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24024				
Title of the Course:	VLSI Implementation of DSP Structures				
Designation:	ELECTIVE course				
Pre-Requisite:	EC23102/EC24102				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Understand the overview of DSP concepts

CO2: Improve the speed of digital system through transformation techniques.

CO3: Perform Pipelining and parallel processing in FIR systems to achieve high speed and low power.

CO4: Perform Pipelining and parallel processing in IIR systems and adaptive filters and understand clocking issues and asynchronous system

Topic Covered:		**Lectures**
UNIT-I	An overview of DSP concepts, Representations of DSP algorithms. Loop bound and iteration bound.	7
UNIT-II	Transformation Techniques: Retiming, Folding and Unfolding.	7
UNIT-III	Pipelining of FIR filters. Parallel processing of FIR filters. Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing. Systolic Architecture Design.	10
UNIT-IV	Pipeline interleaving in digital filters. Pipelining and parallel processing for IIR filters. Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.	8
UNIT-V	Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining, Implementation of wave- pipelined systems, Asynchronous pipelining.	8

Text Books/ Reference Material:

1. “VLSI Digital Signal Processing Systems”, K. K. Parhi, John-Wiley.
2. “Digital Signal Processing with FPGAs”, U. Meyer -Baese, Springer.
3. “VLSI Signal Processing”, W. Burleson, K. Konstantinides, T.H. Meng.
4. “Digital signal processing in VLSI”, R.J. Higgins.
5. “VLSI and modern signal processing”, S.Y.Kung, H.J. Whitehouse

Department:	**Electronics and Communication Engineering**				
Couse Number:	EC 24025				
Title of the Course:	System and Data Security				
Designation:	ELECTIVE COURSE				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	**0**	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: **Understand how information security can counteract attempts to attack an individual's infosphere.**

CO2: **Learn the fundamentals of cryptography.**

CO3: **Develop and implement physical security**

CO4: **Ensure infrastructure and network security**

Topic Covered:		**Lectures**
UNIT-I	Introduction and security trends. General security concepts and introduction to what is an "infosphere". Inside the security mind. Operational security and people's role in information security.	**5**
UNIT-II	Cryptography, internet standards and physical security. Network security and infrastructure. Authentication and wireless. Intrusion Detection Systems and Security Baselines. Attacks and E-mail. Web security and software security. Disaster planning and risk management. Change and privilege management.	**8**
UNIT-III	Information security for client devices. Integrity of data, hash function, digital signature, public key certificate and public key infrastructure, denial-of-service, traceback, DoS defence, network monitoring, fundamental NIDS issues, evaluating detectors, the threat of worms, worm detection/defence, scanning, inferring activity, forensics.	**11**
UNIT-IV	Securing protocols, authentication, identity, anonymity, censorship, surveillance, legality and ethics, architecture, botnets, spam, cybercrime. Memory safety, privilege separation, capabilities, sandboxing.	**8**
UNIT-V	Security problems with TCP/IP, Kerberos, SUNDR, CryptDB, Merkle trees, Bitcoin, secure messaging, differential privacy introduction.	**8**

Text Books/ Reference Material:

1. Security Engineering, Ross Anderson, John Wiley & Sons, 2001.
2. Introduction to Modern Cryptography, Jonathan Katz and Yehuda Lindell, CRC Press, 2007.
3. Cryptography Engineering, Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, Wiley, 2010.
4. Information Security: Principles and Practice, Mark Stamp, John Wiley & Sons, 2006
5. Applied Cryptography, Bruce Schneier, 2nd Edition, John Wiley & Sons, 1996.
6. Network Security: Private Communication in a Public World, Charlie Kaufman, Radia Perlman, Mike Speciner, 2nd Edition, Prentice Hall, 2002.

Department:	**Electronics and Communication Engineering**
Couse Number:	EC 24026
Title of the Course:	Data Analytics
Designation:	ELECTIVE COURSE
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	**0**	**0**	**3**	**3**

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: **Find a meaningful pattern in data**
CO2: **Graphically interpret data**
CO3: **Implement the analytic algorithms**
CO4: **Handle large scale analytics projects from various domains**

Topic Covered:

		Lectures
UNIT-I	Elements, variables, and data categorization. Levels of measurement, data management and indexing. Introduction to statistical learning and R-programming.	**8**
UNIT-II	Measures of central tendency, measures of location of dispersions, practice and analysis with R.	**8**
UNIT-III	Basic analysis techniques, statistical hypothesis generation and testing, Chi-square test, t-test, analysis of variance, correlation analysis, maximum likelihood test, practice and analysis with R.	**10**
UNIT-IV	Regression analysis, classification techniques, clustering, association rules analysis, practice and analysis with R.	**7**
UNIT-V	Understanding business scenarios, feature engineering and visualization, scalable and parallel computing with Hadoop and Map-Reduce, sensitivity analysis.	**7**

Text Books/ Reference Material:

1. The Elements of Statistical Learning, Data Mining, Inference, and Prediction (2^{nd} Edn.), Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer, 2014
2. An Introduction to Statistical Learning with Applications in R, G James, D. Witten, T. Hastie, and R. Tibshirani, Springer, 2013.

OPEN ELECTIVE

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24041				
Title of the Course:	Electronic circuit and Devices				
Designation:	**Open Elective**				
Pre-Requisite:	**ES221****				
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: To understand the working principle and application of OPAMP.

CO2: To understand the working of different types of regulators.

CO3: Understanding the concept of tuned amplifier.

CO4: To study different types of power control switching circuits.

Topic Covered:		**Lectures**
UNIT-I	Operational Amplifier: Introduction to op-amp, offset voltage/currents, CMRR, Feedback amplifier, Linear and Nonlinear application, active filters, performance comparison of typical op-amp (741C, LM411, LM118, LM108, QD611.)	8
UNIT-II	Regulated Power Supply: Regulated power supply design, capacitive(CRC) filter based power supply, Linear series regulators, single op-amp regulator, three terminal regulators, adjustable power supply, Linear ICs such as LM78XX, LM79XX, LM317, LM 337, Switched capacitor conversion (LM-7660). Switching power supply, Basic principles, Buck regulator, and Boost regulator.	8
UNIT-III	Tuned Amplifiers: Single tuned circuit, FET & BJT amplifier, FET tuned amplifier, tuned transistor amplifier with tuned load, narrow band approximation and tuning (Synchronous & Stagger), cascade tuned IF amplifier, Design of tuned amplifier, oscillator possibility and sensitivity. Oscillators: Wein bridge, phase shift, twin T and crystal oscillators.	12
UNIT-IV	Power Switches and ICs: Introductory idea and use of SCR, Diac, Triac and UJT circuits. Integrated Circuits: Introduction to IC, familiarization with popular IC NE/SE-555, 7400 7402, 7406, Audio and Video amplifiers.	12

Text Books/ Reference Material:

1.Basic Electronics and Linear Circuits, 6th Ed., N.N. Bhargav, D.C. Kulshreshta, S.C.
2. Gupta,Tata McGraw Hill, New Delhi, 2001
3.Electronics Principles, 6th Ed., A.P. Malvino, Tata McGraw Hill, New Delhi, 1999.
4.Micro Electronics, 2nd Ed., J. Millman, Arvin Grabel, Tata McGraw Hill, New Delhi,1999.
5.Integrated Electronics, J. Millman, & C.C. Halkias, Tata McGraw Hill, New Delhi, 1999

Department:	**Electronics and Communication Engineering**
Course Number:	EC24042
Title of the Course:	Instrumentation and Measurements
Designation:	Open elective
Pre-Requisite:	

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0	3	3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Concepts of generalized measurement system,

CO2: To study the working of AC and DC bridges for measurement of different type of measurements.

CO3: Recognize the kind of instrument suitable for typical measurements and understand theconcepts popular instruments like cathode ray oscilloscope and its usages.

CO4: Acquire the details of various transducers which are used to measure strain, temperatureetc.

Topic Covered:		**Lectures**
UNIT-I	Generalized Measurement system: Accuracy, Precision, Fidelity, speed of response, static & dynamic performance characteristics, dynamic- step response, ramp response of first order instrument. Classifications of errors, error analysis of measurement.	12
UNIT-II	Introduction to DC and AC bridges for measurement of voltage / current / resistance /capacitance and inductance.	8
UNIT-III	Principle and Working of voltmeter, ammeter and ohmmeter, Introduction to DVM, Electronic multimeter. Cathode Ray Oscilloscope- Introduction, cathode ray tube, electron gun, and deflection plates, basic CRO circuit, Lissajous pattern. Digital multimeter, Signal generator and Function generator using multi op-amp and crystal.	12
UNIT-IV	Definition of transducer, classification, resistive, capacitive, inductive, magnetic, optical, piezoelectric, pneumatic.	8

Text Books/ Reference Material:

1. Principles of Electronics instrumentation and measurements. Berlyn and Getz(McMillan Pub. Co.)
2. A Course in Electrical Electronics Measurements and instrumentation. A.K. Sawhney (Dhanpat Roy & Co.).
3. Modern Electronics Instrumentation and Measurement Techniques Albert D. Heltrick, W. D. Cooper. (PHI).
4. Murthy DVS – Transducers & Instrumentation, PHI, ND, 1995.
5. Elements of Electronic Instrumentation and Measurement. Joseph J. Carr. Pearson Education
6. PC-Based Instrumentation Concept and Practice N. Mathivanan PHI

Department:	**Electronics and Communication Engineering**				
Course Number:	EC24043.				
Title of the Course:	Electronic Engineering Materials.				
Designation:	Open ELECTIVE course				
Pre-Requisite:					
Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0		3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1:	Understanding of the properties of conducting materials, their alloys and knowledge of semiconducting materials, their types, carrier concentration and fermi distribution function.
CO2:	Define magnetic materials and describe their properties.
CO3:	Understand the optical properties of materials and their applications.
CO4:	Discuss the various properties of Insulating, piezo-electric and dielectric materials.

Topic Covered:		**Lectures**
UNIT-I	Electronic Engineering Materials Conducting materials - Effect of temperature on resistivity of different conducting materials, Metal and alloys for fuses, Properties and specifications of wire, cable and antenna material. Semiconducting materials - Element and compound semiconductors and their properties, Carrier concentration in semiconductors, Variation of fermi level and carrier concentration with temperature, Hall effect.	10
UNIT-II	Magnetic materials – Different types of magnetic materials and their properties, Diamagnetism, Paramagnetism, ferromagnetism, anti ferromagnetism and ferrimagnetism. Hard and Soft magnetic materials, Magnetic materials used at high frequencies. Frequency dependence of dielectric constant; Ferroelectricity and Piezoelectricity in materials.	10
UNIT-III	Optical properties of materials: metals, insulators and semiconductors, Phosphorescence and fluorescence, Different phosphors used in CRO screens, Liquid crystal as display, materials for LEDs, Photoconductivity and photo conducting materials. Light interaction with solids; Absorption, Transmission and Reflection; Luminescence; Photoconductivity; Lasers.	10
UNIT-IV	Insulating materials- Atomic interpretation of dielectric material of mono atomic gases and poly atomic molecules, general feature of static dielectric constant of solids, piezo electricity and piezoelectric materials, Dielectric properties in alternating fields: Frequency dependence of electronic and ionic polarizability, complex dielectric constant, dielectric relaxation and losses, temperature dependence, superconductors.	10

Text Books/ Reference Material:

1. Electronics Engineering Materials and Devices, John Allyson, 1st Ed. ,Tata McGraw Hills 1973
2. Introduction to Materials Science for Engineers, James Shakelfolk, 6th Ed. Macmillan Publishing Co. 2007
3. Materials Science and Engineering, V. Raghavan, 2nd Ed. Prentice Hall of India. 2015
4. Electrical Engineering Materials, A.J.Dekker, 3rd Ed. Prentice Hall of India, New Delhi 2007

Subject opted by CSE Department:

Department:	**Electronics and Communication Engineering**
Course Number:	EC23121
Title of theCourse:	Signals and Systems
Designation:	REQUIRED course
Pre-Requisite:	MA212**

Course Details:	**Lectures**	**Tutorial**	**Practical**	**Contact Hours**	**Credits**
	3	0	0		3

Course Assessment Methods:

Theory:	**Assignments & Quiz:**	**20% of 100**
	Mid-Semester Exam:	**30% of 100**
	End-Semester Exam:	**50% of 100**

Course Outcomes:

CO1: Represent and characterize the signals and systems using linear algebra.

CO2: Classify systems based on their properties and determine the response of LTI system using convolution.

CO3: Analyse the spectral characteristics of continuous-time and discrete-time periodic aperiodic signals using Fourier analysis.

CO4: Apply the Laplace transform and Z- transform to analyse continuous-time and discrete-time signals and systems and understand the process of sampling and the effects of underSampling.

Topic Covered:		**Lectures**
UNIT-I	Continuous and discrete time signals: Classification of Signals, Transformation of independent variable of signals, Basic continuous-time and discrete-time signals. Energy and power signals. Unit Impulse, Unit Step Functions and Ramp Function. Periodic and aperiodic signals, Orthogonal signal.	8
UNIT-II	Basic system properties: Analysis of Continuous-time and Discrete-time LTI Systems and their properties. Linear constant co-efficient differential equations and difference equations.	8
UNIT-III	Fourier-series and Fourier Transform representation of Continuous-time Signals and their properties. Discrete-Time Fourier-series and Discrete-Time Fourier Transform representation of discrete-time Signals and their properties.	7
UNIT-IV	Laplace Transform and its properties. Unilateral Laplace Transform. Analysis of LTI systems using Laplace-transform. Z-transform and its properties. Unilateral Z-Transform. Analysis of LTI systems using Z -transform.	7
UNIT-V	State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems.	10

Text Books/ Reference Material:

1. Signals & Systems, Alan V. Oppenheim, Alan S. Willsky , S. Hamid Nawab, 2ndEd., Pearson Education. 2013
2. Signals and Systems, S.Haykin and B. VanVeen , 2nd Ed. Wiley.2007
3. Principles of Linear Systems and Signals, B.P. Lathi, 2nd Ed. Oxford.2009
4. Signal Processing and Linear Systems, B.P. Lathi, Oxford University Press.
5. Introduction to Signals and Systems, Douglas K. Lindner, McGraw Hill.