Revised Syllabus of
PG Programs (CBCS)

M.Sc. (Electronics and Communication Technology)

&

M.Sc.(Microelectronics & Advanced Communication)

(Effective from August, 2016 Academic session)

Department of Electronics and Communication Technology

Gauhati University

Guwahati - 781014, Assam, India

PG PROGRAMS OFFERED (DURATION: 02 YEARS)

NAME OF THE PG PROGRAMS	PROGRAM CODE	TOTAL MARKS & CREDITS
M.Sc. (Electronics & Communication Technology)	ECT	**2300 (L + T + P = 98)**
M.Sc. (Microelectronics and Advanced Communication)	MEAC	**2300 (L + T + P = 98)**
L= Lecture, T=Tutorial, P=Practical		

PROGRAM OUTCOMES

MSc (ECT) & MSc(MEAC)

To produce skilled manpower suitable for employment / engagement in

- **R&D sectors and industries related to Electronics**
- **Academic Institutes / Organizations**
- **Entrepreneurship, Consultancy & Startup programs related to Electronics**
- **Self-employment in repair and maintenance of consumer electronics gadgets**

PROGRAM SPECIFIC OUTCOMES

MSc (ECT)	MSc(MEAC)
To produce skilled manpower with emphasis on ▪ Antennas Design ▪ Signal Processing ▪ Nanoelectronics	To produce skilled manpower with emphasis on ▪ Integrated Circuits ▪ Nanoelectronics ▪ Advanced Communication

COURSE STRUCTURE OF THE PG PROGRAMS

FIRST SEMESTER : MSc (ECT) & MSc (MEAC) COURSES				
PAPER CODE	NAME OF THE PAPER	MARKS	CREDITS(L-T-P)	TOTAL MARKS
ECT1014/MEAC1014	A) Electronic Materials	50	L = 03, T=01	600 Marks (Minimum 240 Hours) (24 Credits)
	B) Mathematical Methods	50		
ECT1024/MEAC1024	Network Analysis	100	L = 03, T=01	
ECT1034/MEAC1034	A)Applied Quantum mechanics	50	L = 03, T=01	
	B)Semiconductor Devices	50		
ECT1044/MEAC1044	A)Digital Electronics	50	L = 03, T=01	
	B)Microprocessor-I	50		
ECT1054/MEAC1054	A)Programming in C++	50	L= 03, P = 01	
	B)Operating Systems	50		
ECT1064/MEAC1064	Laboratory-I	100	P = 03, T=01	
	A)Analog and Digital Design	50		
	B)Microprocessor-I	50		

SECOND SEMESTER: MSc (ECT) & MSc (MEAC) COURSES				
PAPER CODE	NAME OF THE PAPER	MARKS	CREDIT(L-T-P)	TOTAL MARKS
ECT2014/MEAC2014	A) Semiconductor Device Fabrication Technology	30	L = 03, T=01	600 Marks (Minimum 240 Hours) (24 Credits)
	B) Linear Electronic Circuits	70		
ECT2024/MEAC2024	A)Electromagnetics	50	L = 03, T=01	
	B)Microwave -I	50		
ECT2034/MEAC2034	A)Power Electronics	50	L = 03, T=01	

	B)Control System	50		
ECT2044/MEAC2044	Communication System	100	L = 03,T = 01	
ECT2054/MEAC2054	A) Opto-Electronics	50	L = 03, T=01	
	B) Instrumentation	50		
ECT2064/MEAC2064	Laboratory-II	100	P = 03, T=01	
	A) Microwave, Control System & Power Electronics	50		
	B) Communication System	50		

THIRD SEMESTER : MSc (ECT)				
PAPER CODE	NAME OF THE PAPER	MARKS	CREDIT(L-T-P)	TOTAL MARKS
ECT3014	A) Mechatronics	50	L =03, P=01	600 Marks (Minimum 240 Hours) (26 Credits)
	B) Electronic System Design	50		
ECT3024	A) Signals & Systems	50	L = 03, P=01	
	B) Digital Communication	50		
ECT3034	A) Microprocessor-II	30	L = 03, P = 01	
	B) Micro-controller	70		
ECT3046	**Elective Papers**			
	A) Antenna Modeling & Design	100	L = 04, P= 01, T=01	
	B) Microwave-II	100		
	C) Introduction to Nanoscience & Nanotechnology	100		
ECT3054	Dissertation / Project Phase-I	100	T=01,P = 03	
ECT3064	Laboratory-III	100	P = 03, T=01	
	Advanced Circuit Design			

THIRD SEMESTER: MSc (MEAC) COURSES				
PAPER CODE	NAME OF THE PAPER	MARKS	CREDIT(L-T-P)	SEMESTER TOTAL
MEAC3014	CMOS Circuit Design	100	L = 03, T=01	600 Marks (Minimum 240 Hours) (26 Credits)
MEAC3024	A) Signals & Systems	50	L = 03, P=01	
	B) Digital Communication	50		
MEAC3034	A) Microprocessor-II	30	L = 03, P = 01	
	B) Micro-controller	70		
MEAC3046	Introduction to Nanoscience & Nanotechnology	100	L = 04, T=01, P=01	
MEAC3054	Dissertation / Project Phase-I	100	P = 03, T = 01	
MEAC3064	Laboratory-III	100	P = 03, T = 01	
	Advanced Design Laboratory			

FOURTH SEMESTER : MSc (ECT)				
PAPER CODE	NAME OF THE PAPER	MARKS	CREDIT(L-T-P)	TOTAL MARKS
ECT4014	Electrical Machines	100	L = 03, T=01	500 Marks (Minimum 200 Hours) (24 Credits)
ECT4024	Communication Networks	100	L = 03, T=01	
ECT4034	Photonics	100	L = 03, T=01	
ECT4046	**Elective Papers**			
	A) Web Technology	100	L = 04, P = 01, T=01	
	B) Digital Signal Processing	100		
	C) Introduction to Nanoelectronics (**Under CBCS with Dept. of Instrumentation & USIC**)	100		
ECT4056	Dissertation / Project Phase-II	100	T = 02, P = 04	

FOURTH SEMESTER: MSc (MEAC) COURSES				
PAPER CODE	NAME OF THE PAPER	MARKS	CREDIT (L-T-P)	SEMESTER TOTAL
MEAC4014	Digital system design with VHDL	50	L = 03, P=01	500 Marks (Minimum 200 Hours) (24 Credits)
MEAC4024	Communication Networks	50	L = 03, T=01	
MEAC4034	Introduction to Nanoelectronics	100	L = 03, T=01	
MEAC4046	**Elective Papers**			
	A) Web Programming	100	L = 04, P = 01, T=01	
	B) Satellite Communications,	100		
	C) Mobile Communications	100		
	D) Fiber Optic Communications	100		
	E) Biomedical Instrumentation (IAP4046A) **(Under CBCS with Department of Instrumentation & USIC)**	100		
MEAC4056	Dissertation / Project Phase-II	100	T = 02, P = 04	

Detailed syllabus of the Courses in PG Programs

FIRST SEMESTER (ECT/MEAC)

ECT 1014/MEAC1014: Electronic Materials and Mathematical Methods (L= 03, T = 01, P= 0)

Course Outcomes: By the end of these courses, students will be able to

- Categorize different types of materials used in fabrication of semiconductor devices
- Explain and compare important properties of the materials
- Justify the need for the materials
- Describe different mathematical functions and theories needed for solving problems in Electronic Science and Engineering
- Solve applied mathematical problems for Electronic Science and Engineering

(Course instructor should introduce use of MATLAB/MATHEMATICA as part of the course on Mathematical Method)

A) Electronic Materials (50 marks)	
Unit-1	**Crystalline structure**: Single crystals - unit cells, Bravais lattices, crystal planes, Miller indices, X-ray diffraction; Lattice vibrations; properties of polycrystalline and amorphous materials, crystalline defects, X-ray diffraction (**10marks**).
Unit-2	**Semiconductors:** Classification of solids - insulator, semiconductor and conductors; Intrinsic and extrinsic Semiconductors, Compound semiconductors – binary, ternary and quaternary types and their properties; carrier generation and recombination, carrier scattering in semiconductors. Electronic properties and application of semiconductor – semiconductor junction, metal – semiconductor junction, metal – insulator junction, insulator – semiconductor junction in electronic device fabrication. Low-dimensional semiconductor structures: super lattice, quantum wells, wires and dots and their application in electronics; organic and polymer materials for electronics (**10 marks**).
Unit-3	**Conductors:** Free electron theory of metals, Electrical conductivity and resistance, Boltzmann transport equation, thermionic emission and photoelectric effect, contact potential between metals, metallic alloys – interstitial and substitutional solid solutions, mutual solubility. Properties of common metals (Gold, Copper, Aluminum, Tin, Lead etc.), and their applications in fabrication of electrical components and electronic devices (**10 marks**).
Unit-4	**Dielectrics:** Dielectric polarizations - electronic, ionic, orientation types, dielectric breakdown; alternating field behavior of dielectrics – complex dielectric constant, dielectric loss and relaxation time. Properties of dielectrics such as mica, ceramics, Silicon dioxide, Silicon Nitride etc., and their applications in fabrication of electrical components and electronic devices (**10 marks**).
Unit-5	**Magnetic materials and Superconductors:** Theory of ferromagnetic, anti-ferromagnetic, ferrimagentic, paramagnetic and diamagnetic materials; their properties and application in electrical and electronic engineering. Physics of superconductors and superconducting materials, Josephson effect, SQUID, High temperature superconductivity and its applications (**10 marks**).
B) Mathematical Methods (50 marks)	
Unit-1	**Linear Algebra:** Introduction, Vector Spaces, Solutions of Linear Systems, Important Subspaces associated with a matrix, Orthogonality, Eigenvalues and Eigenvectors, Diagonalizable Matrices, Hermitian Matrices, General Matrices, Jordan Canonical form (**7 marks**).

Unit-2	**Numerical Analysis:** Principles of floating point computations and rounding errors; systems of linear equations, eigenvalue problems; interpolation, approximation by polynomials, data fitting and least squares approximation; Numerical Integration: integration by interpolation, adaptive quadratures and Gauss methods; Initial Value Problems for Ordinary Differential Equations: Runge-Kutta methods, multi-step methods, predictor and corrector scheme, stability and convergence analysis; Two Point Boundary Value Problems : finite difference methods with convergence results (**7 marks**).
Unit-3	**Laplace and Fourier Transforms:** Concept of Transforms, Laplace Transform(LT) and its existence, Properties of Laplace Transform, Evaluation of LT and inverse LT, Evaluation of integral equations with kernels of convolution type and its Properties, Complex form of Fourier Integral, Introduction to Fourier Transform, Properties of general (complex) Fourier Transform, Concept and properties of Fourier Sine Transform and Fourier Cosine Transform, Evaluation of Fourier Transform, Solution of ordinary differential equation and one dimension (**12 marks**).
Unit-4	**Special Functions:** Gamma and Beta functions, Bessel function, Error function, Legendre polynomials, Hermite and Laguere polynomials, Chebyshev and Jacobi polynomials, Hypergeometric functions, Laplace equation, Poisson's Equation and Engineering applications (**12 marks**).
Unit-5	**Probability & Statistics:** A review of concepts of probability and random variables: Classical, relative frequency and axiomatic definitions of probability, addition rule, conditional probability, multiplication rule, Bayes' Theorem. Random Variables: Discrete and continuous random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function. Standard Distributions: Uniform, Binomial, Geometric, Negative Binomial, Poisson, Exponential, Gamma, Normal. Sampling Distributions: Chi-Square, t and F distributions. Estimation: The method of moments and the method of maximum likelihood estimation, confidence intervals for the mean(s) and variance(s) of normal populations. Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test, tests of hypotheses on a single sample, two samples (**12 marks**).

Suggested readings:

Electronic materials:

1. Solid State Physics - A J Dekker, McMillan Publisher, India
2. An Introduction to Solid State Physics - Charles Kittel, Wiley Publishers
3. Semiconductor Devices – Physics and Technology - S.M.Sze, Wiley
4. Electrical properties of materials - L.Solymar and D Walsh

Mathematical Methods:

1. Engineering Mathematics – Erwin Kreyszig, Wiley
2. Linear Algebra and its Applications-, by David Lay, published by Pearson/Addison Wesley
3. Special Functions for Scientists and Engineers - W. W. BELL
4. An Introduction to Statistics, Vol-I &II - L. Choudhury, Kitap Ghar, Guwahati-I
4. Mathematical Statistics - Kapoor and Gupta, Sultan Chand, New Delhi
5. Probability, Random Process & Stochastic Process - Populis, John wiley

ECT 1024/MEAC1024: Network Analysis (100 marks) (L= 03, T = 01, P= 0)

Course Outcomes: By the end of this course, students will be able to

- Describe elements of electrical circuits , circuit laws, theories and process for solving nodal and loop equations
- Explain the processes for determining transient and steady state responses of circuits to different input signals in time-domain as well as frequency domain
- Design and synthesis networks based on transfer functions

(Course instructor should introduce use of PSPICE/MATLAB wherever necessary as part of the course)

Unit-1	**Network analysis & review of network theorems:** Elements of a Network, Network geometry; Graph and Tree of a network, Node and Mesh analysis, Superposition, Maximum power transfer, Thevenin's and Norton's theorem etc.(**20 marks**).
Unit-2	**Network parameters of two port network:** Short circuit admittance, open circuit impedance, transmission and Hybrid parameters, T-section and π section representation of a two port network, Symmetrical, Ladder and Lattice network (**20 marks**).
Unit-3	**Transient response and Laplace transformation of networks:** Step function response of linear R-L, R-C, and R-L-C network. Network analysis using Laplace transformation: Laplace Transformation and inverse Laplace transformation, Application of Laplace transformation in R-L, R-C and R-L-C networks; Response to R-L, R-C and R-L-C networks to step & sinusoidal voltage, impedance and transfer function of a two port network. Phasor diagram, Driving point impedance and transfer impedance, magnitude and phase response curves in S-planes, Poles and Zeroes, Method of partial fractions (**25 marks**).
Unit-4	**Fourier analysis:** Fourier analysis of a periodic signal, Fourier integral, Power and Energy relationship in Network by Fourier method; Fourier transform analysis of no-periodic signals (**10 marks**).
Unit-5	**Network Syntheses:** Positive real functions; Hurwitz Polynomials, Realizability condition of network, Foster 1st and 2nd form of network synthesis for one port network, Cauer 1st and 2nd form (**10 marks**).
Unit-6	**Network Filters:** Passive Filters, High pass, Low pass, Band pass and band elimination filters, m-derived filters, Butterworth approximation; Chebychev and Bessel response; Filter Approximation and Frequency Transformation (**15 marks**).

Suggested Reading

1. Network analysis – G.K. Mittal, Khanna Publishers.
2. Network Theory and filters Design – V.K. Aatre, Wily Eastern Ltd.
3. Engineering Circuit Analysis – W.H. Hayt and J.E. Kemmerly, McGraw Hill, 1978.
4.Network Analysis – M.E. Van Valkenberg, Prentice Hall of India Pvt. Ltd,
5.Network Analysis – Ghosh, PHI
6.Linear Circuit Analysis – Liu, Oxford University Press;
7.Network Analysis – Stanlay, Pearson Education;

ECT 1034/MEAC1034:Applied Quantum Mechanics and Semiconductor Devices (100 marks) (L= 03, T = 01, P= 0)

Course Outcomes: By the end of these courses, students will be able to

- Explain the applications of quantum mechanics in Electronics Science and Engineering
- Illustrate mathematical theory and significance of wave functions , Schrodinger equation and quantum mechanical operators
- Solve quantum mechanical problems related to semiconductor device physics, nanoscience and nanotechnology
- Explain energy band theory of solids and its significance in electronic devices
- Explain structure and physics of operation of various electronic devices and applications
- Solve mathematical problem related to device physics and applications

(Course instructor should introduce use of PSPICE as part of the course on Semiconductor Physics)

A) Applied Quantum mechanics (50 marks)	
Unit-1	Historical Developments of Quantum mechanics (QM), importance of QM in Electronics.
Unit-2	Experimental verification of de Broglie hypothesis, concept of wave packet and wave function, uncertainty principle and its applications (**5 marks**).
Unit-3	Schrödinger wave equation, probability density current, Free electrons, 1D & 3D space, electrons confined to a bounded region of space: 1D and 3D rigid potential box, quantum confinement, degenerate and non-degenerate energy levels; Transmission and reflection of unbounded states: potential step and impedance matching (**15 marks**)..
Unit-4	Particle tunneling, Tunnel diode, electron tunneling limit to reduction in size of CMOS transistor, concept of resonant tunneling, double barrier resonant tunneling diode, heterostructure bipolar transistor with resonant tunnel – barrier (**15 marks**)..
Unit-5	Electrons subject to periodic potential: Band theory of solids, concept of effective mass & holes; Density of states (DOS) in bulk semiconductor, brief idea of DOS in low dimensional semiconductor structure, concept of quantum conductance (**15 marks**)..
B) Semiconductor Devices (50 marks)	
Unit-1	**Semiconductors:** Direct and indirect semiconductors, energy bands in intrinsic and extrinsic semiconductors, law of mass action; density of states, Fermi Dirac distribution function, carrier statistics; carrier transport phenomena – drift and diffusion currents, Einstein's relationship, carrier scattering, generation and recombination processes (**10 marks**) .
Unit -2	**Junction diodes:** Homojunctions and hetero-junctions, device structure of junction diode, different doping profiles of pn-junction; Energy band diagram of pn-juction diode, built-in potential and depletion width of uniformly doped step and one sided junction under thermal equilibrium and biased conditions, diode equation, I-V characteristics of diode and thermal effect, breakdown mechanisms in junction diodes; operation of Zener diode, tunnel diode, Schottky diode, varactor diode, basics of light emitting diodes and photodiodes. Diode circuits: equivalent models of diode, AC & DC circuits containing diodes – rectifier circuits, DC voltage regulator, clipping and clamping circuits. Switching response of signal diodes and power diodes, study of diode datasheets (**10 marks**).
Unit -3	**Bipolar Junction Transistor:** Device structure of pnp and npn transistors, detailed analysis of current flow in BJT, I-V characteristic curves for BJT in CE, CB and CC configurations, determination of *h*-parameters from I-V curves, small signal equivalent circuit of BJT, leakage current, base-width modulation, breakdown phenomena, thermal effects; α & β cut off frequencies, basics of phototransistor and hetero-junction BJT. Basic BJT circuits: DC load line & bias point,

	biasing schemes – fixed current bias, collector to base bias, emitter current bias, potential divider bias; Bias stability factor; basic BJT circuits for signal amplification, frequency response of BJT amplifiers, study of BJT datasheets (**10 marks**).
Unit-4	**Field Effect Transistors -JFET and MOSFET physics:** Device structure of n-channel and p-channel Junction Field Effect Transistor (JFET); detailed analysis of current flow, linear and saturation regions of I-V characteristics, pinch off voltage, equation of drain current, channel length modulation. Device structure of n-channel and p-channel Metal Oxide Semiconductor Field Effect Transistor (MOSFET), enhancement and depletion type MOSFETs; detailed analysis of current flow, channel accumulation and inversion states, threshold voltage, sub-threshold, linear and saturation regions of I-V characteristics, channel length modulation, channel pinch off, equation of drain current; Basic JFET & MOSFET circuits: DC load line & bias point, biasing schemes, basic circuits for signal amplification, small signal AC equivalent circuits of JFET and MOSFET, frequency response of MOSFET/JFET amplifiers, Study of JFET & MOSFET datasheets (**10 marks**).
Unit-5	**Basics of negative and positive feedback in amplifier:** General theory of positive and negative feedback, Barkhausen criterion; Open loop and close loop gain, negative Feedback topologies and their effects on amplifier characteristics, positive feedback in oscillator circuits (**5 marks**).
Unit-6	**Basics of operational amplifier (OP-AMP):** Ideal and real characteristics of OP-AMP; internal building blocks of OP-AMP, comparison between BJT and FET based OP-AMPs; frequency response and gain of OP-AMP in open loop and closed loop, frequency compensation in OP-AMP; Basic OP-AMP circuits: non inverting & inverting amplifiers, comparators, adder, subtractor, log amplifier and oscillator circuits, active filters using OP-AMP, OP-AMP datasheets(**5 marks**).

Suggested Reading:

Applied Quantum Mechanics:

1. Applied Quantum Mechanics – AFJ Levi, Cambridge Univ. Press
2. Concepts of Modern Physics – Arthue Beiser
3. Fundamentals of Nanoelectronics – George W. Hanson, Pearson Pub.

Semiconductor Devices:

1. Electronic Devices & circuits. – David A. Bell, PHI
2. Semiconductor Devices – Jasprit Singh, John Wiley
3. Semiconductor Devices – Physics and Technology – S.M.Sze, Wiley
4. Electronic Devises & Circuits Theory – Boylestad & Nashalsky. Pearson Education
5. Electronic Device & Circuit – Millman-Halkias, Tata McGraw Hill.

ECT 1044/MEAC1044: Digital Electronics & Microprocessor-I (100 marks)
(L= 03, T = 01, P= 0)

Course Outcomes: By the end of these courses, students will be able to

- Explain difference between digital and analog system
- Illustrate use of number systems, Boolean algebra, K- map in digital system design
- Explain operation and design of logic gates, flip-flops, registers, counters, memories etc.
- Solve mathematical problem related to design of digital system
- Explain the building blocks of digital computers
- Illustrate architecture and operating modes of 8085 microprocessor
- Illustrate skills on 8085 assembly language programming and interfacing of peripheral devices
- Justify the need for designing microprocessor based system

***Course instructor should introduce use of**

- **PSPICE simulator/Other available software as part of the course on Digital Electronics**
- **8085 simulator as part of the course on Microprocessor**

A) Digital Design (50 marks)

Unit-1	**Number system:** Binary, octal and hexadecimal numbers, representation of signed integers, binary arithmetic on signed and unsigned integers and detection of overflow and underflow, Weighted Binary Codes: BCD, 2421, Reflective and sequential codes, Non-weighted codes: Excess -3 Codes, Gray codes, Error detecting codes, Error correcting codes, Alphanumeric Codes: ASCII Code, EBCDIC Codes and Hollerith code (**5 marks**).
Unit-2	**Boolean algebra and logic gates:** Boolean operators, Rules (postulates and basic theorems) of Boolean algebra, Dual and complement of a Boolean expression, Sum of products and product of sums forms. Canonical forms. Conversion between different forms, Conversion between Boolean expression and truth table; Logic gates, Implementing logic expressions with logic gates (logic circuits) (**10 marks**).
Unit-3	**Digital logic families:** Designing of basic logic gates with diode and transistor ; elementary idea of DTL, TTL, RTL, ECL,12L logic family and characteristics ; 7400 series, understanding of the basic NAND gate (TTL) (**5 marks**)
Unit-4	**Combinational circuit:** Boolean expressions and their simplification by algebraic method. Karnaugh map method and Quine-McCluskey method, Don't Care conditions. Multiplexer, demultiplexer, encoder, decoder, Half-adder, Full-adder, magnitude comparator, Parity Checkers: Basic concepts, Design of parity checkers, parity generation, Code converters, Binary –to- Gray and Gray-to-Binary Code converter; Concept of magnitude comparator (**10 marks**).
Unit-5	**Sequential circuit:** Simple R-S flip-flop or Latch, Clocked R-S Flip-flop, D flip-flop. J-K flip-flop, T flip-flop, Master-Slave flip-flop, J-K Master- Slave JK flip –flop. Asynchronous preset and clear, edge triggering and level triggering. Registers: Shift registers, parallel/serial in, parallel/serial out. Buffer Counter design: different types of counters like asynchronous and synchronous, UP and Down, ring, Johnson etc. counter design using state diagram, state table and state equation (**10 marks**).
Unit-6	**Semiconductor Memory:** Classification of memories, Main Memory and Secondary Memory, Sequential Access Memory, Static and Dynamic Memory, Volatile and Non-volatile Memory, Concept of ROM, PROM, EPROM, RAM, DRAM, SDRAM, DDRAM, PSRAM, Memory Decoding, Programmable Logic Devices (PLD), Programmable Logic Array (PLA) (**5 marks**)
Unit-7	**IC Timer 555:** Basics of IC555 Timer, Monostable and Astable Multivibrator using IC555, Schmitt Trigger using IC555, Some other applications (**5 marks**).
B) Microprocessor-I (50 marks)	
Unit -1	**History & evolution of microprocessor:** Introduction to CPU: Components of CPU, block diagram, buses-data, control & address; ALU, Control Unit; main memory & secondary memory; I/O devices (**5 marks**).
Unit -2	**8085 architecture**: Block diagram, registers, PSW, accumulator; instruction cycle and addressing modes; instruction fetch, decode & execute; one, two & three byte instructions; addressing modes (**10 marks**).
Unit-3	**Assembly language programming:** Instruction set of 8085 for data transfer, arithmetic & logical operation, branching and control instructions; stack in 8085 & its application. Time delay generation, timer and counter; application of interrupts (**15 marks**).
Unit-4	**Memory and I/O Interfacing:** Memory addressing – memory mapped I/O; I/O mapped I/O, memory address decoding; interfacing small devices like keyboard,7-segment display, relay, event counter etc; idea of PPIs like 8251, 8255, 8257 & 8279 (block diagram & function only);serial communication standard(RS-232C) (**15 marks**).
Unit-5	Basics of 16-bit processors (introduction to 8086/8088); microcontroller (Introduction to 8051) (**5 marks**)

Suggested Reading:

Digital Design:

1.Digital logic and computer design –M. Mano. PHI.
2.Modern Digital Electronics –R.P. Jain, TMGH
3.Digital Fundamentals –Jain and Floyd, Pearson Education
4.Digital Electronics –Malvino & Leach, Pearson Education
5.Digital Computer Electronics –Malvino, TMGH
6.Digital Design – Morris Mano, Pearson Education
7.Digital Circuits and Design –S. Salivahanan and S. Arivazhagan, Vikash, Publishing Ltd.

8.Digital Techniques – Prof. P. H. Talukdar, N. L. Publications
9.Digital Design – Wakerly, PHI

Microprocessor-I:

1. Introduction to Microprocessors – R.Gaonkar, New age Publication
2. Fundamentals of Microprocessor – B.Ram. Dhanpat Rai
3. 8085 Microprocessor Programming and Interfacing –N. K. Srinath, PHI
4. Microprocessor Based Design – Slater, PHI
5. Microprocessors – Gilmore, MacGraw Hill Publication
6. Microcomputers and Microprocessors – Uffenbeck, PHI

ECT 1054/MEAC1054: Programming in C++ & Operating System (100 marks)
(L= 03, T = 00, P= 01)

Course Outcomes: By the end of these courses, students will be able to

- Explain different generation of computer, organization of computers hardware and software
- Explain the need for assembler, compiler, interpreter, low level & high level programming languages in computer programming
- Illustrate skills on C++ programming
- Illustrate skills on application of C++ programming for solving engineering and scientific problems
- Explain different generation of computer hardware and operating systems
- Explain the function of operating system, driver, firmware, application programs
- Explain about CPU cycle, thread, process, scheduling, deadlock etc.
- Compare open source operating systems with proprietary operating systems

(Course instructor should introduce C++ programming in laboratory sessions)

A) Programming in C++ (50 marks)	
Unit-1	**Introduction:** Assembler, Compiler, Interpreter; Attributes of a C++ programme; Structure of a C++ programme; C+= declarations; Data types; Operators; Order of precedence of operators; I/O process; Pre-processor directives (**5 marks**)
Unit-2	**Control Structures:** Decision making statements; If-else; Nested if-else; Do-while; goto; break; continue; switch; for loop (**5 marks**)
Unit-3	**Array, String and Pointers:** Definition, types; examples of 2-D arrays; examples – matrix addition, transpose, trace etc; String- creation, insertion, concatenation etc; Definition of pointer, pointers and arrays, arrays of pointers (**5 marks**)
Unit-4	**Functions:** Definition- types, parameter passing; referencing; functions and arrays; using of pointers for parameter passing; Prototyping; recursion; file handling (**10 marks**)
Unit-5	**Class and Object:** Structures-definition; Classes-definition, member functions, characteristics of member functions; encapsulation; Declaration of objects, static objects, array of objects; constructors and destructors; operator overloading and type conversion (**10 marks**)
Unit-6	**Inheritance:** Definition; Access specifiers and simple inheritance, types of inheritance- single, multilevel, multiple, hierarchical, hybrid, multipath; abstract classes; Pointers and inheritance; Advantage of inheritance (**5marks**)
Unit-7	**Data Structures:** Definition and examples of data structure, stack, queue, link list; function and data structure; Sorting- selection, insertion, quick; Search- Linear, binary; Dynamic memory allocation (**10 marks**)
B) Operating System (50 marks)	
Unit-1	**Introduction:** Operating system-definition, types, different parts; trends- parallel computing, distributed computing; Open systems; Hardware, software, firmware (**10 marks**)

Unit-2	**Process Scheduling:** Definition of a process; process states, transitions, process control, suspend and process, interrupt processing, nucleus of an operating system; parallel processing; Mutual exclusion, Critical Section; Solution of mutual exclusion; Semaphores; Deadlock- occurrence, prevention, detection and recovery (**10 marks**)
Unit-3	**Storage management:** Storage organization, management strategies, hierarchy; virtual storage, paging, segmentation (**10 marks**)
Unit-4	**File system and I/O management:** File system (function of a file system)- data hierarchy, blocking and buffering, file organization, queued and basic access methods, backup and recovery; I/O management (functions of I/O management subsystem), Distributed computing- OSI view, OSI network management, MAP, TOP, GOSIP, TCP/IP; OS security- requirements, external security, operational security, surveillance, threat monitoring; Introduction to Cryptography (**10 marks**)
Unit-5	**Case Study:** UNIX- Shell, Kernel, File System, Process Management, Memory Management, I/O System, Distributed UNIX; Example of operating system-MS-DOS, Windows, OS/2, Apple Macintosh & Linux (**10 marks**)

Suggested Reading:

Programming in C++:

1. Programming in C++ - Kamthane, Pearson Education;
2. Programming in C++ - Balaguruswamy, TMGH;
3. Let us C++ - Kanitkar, BPB Publishers

Operating System:

1. Operating System – Deitel, Pearson Education
2. Operating System – Tanenbaum, PHI

ECT 1064/MEAC1064: Laboratory-I (100 marks) (L= 0, T = 01, P= 03)

Course Outcomes: By the end of this course, students will be able to

- Illustrate operation and handling of different equipments and instruments needed for testing and characterization of electronic circuits
- Design and study of basic passive as well as active analog circuits based on discrete as well as integrated circuits
- Design and study of basic digital circuits based on discrete as well as integrated circuits
- Illustrate practical skills on troubleshooting and fault finding in rectifier, amplifier, filter circuit etc.
- Illustrate operation and handling of different 8085 microprocessor kits
- Illustrate practical skills on 8085 programming and interfacing

(Course instructor should introduce use of PSPICE simulator/Other available software package as part of the courses)

A) Analog & Digital Design and Microprocessor (50 marks)	
1	Verification of voltage division and current division rule by using DC networks.
2	Design and study of half wave rectifier with and without filter network.
3	Design and study of centre tapped full wave rectifier with and without filter network.
4	Design and study of full wave bridge rectifier with and without filter network.
5	Design and study of DC voltage regulator circuit by using zener diode.
6	Design and study of DC voltage regulator by using Zener diode and BJT.
7	Design and study of first order passive and active low pass RC filter circuits
8	Design and study of first order passive and active high pass RC filter circuits

9	Design and study of first order passive and active band pass RC filter circuits
10	Design and study of first order passive and active band elimination RC filter circuits
11	Design and study of BJT/JFET DC biasing networks by using different biasing schemes
12	Design and study of single stage RC coupled BJT/JFET amplifier circuit
13	Design and study of voltage follower circuit by using BJT
14	Design and study of analog adder and subtraction circuits by using operational amplifiers
15	Design and study of inverting amplifier circuit by using operational amplifier
16	Design and study of non- inverting amplifiers circuit by using operational amplifier
17	Design of comparator circuits by using operational amplifier
18	Design and study of astable multivibrator by using BJTs /555 Timer
19	Design and study of monostable multivibrator by using BJTs /555 Timer
20	Design and study of basic AND, OR, NOT, NAND logic gates by using diode, transistors.
21	Verification of truth tables for basic logic gates by using logic gate ICs.
22	Design and implementation of half adder and full adder circuit by using basic logic gates
23	Design and implementation of 4:1 multiplexer circuit by using logic gates
24	Design and study of single bit magnitude comparator circuit by using logic gates
B) Microprocessor-I (50 marks)	
1	ALP to move a block of data in memory location starting from XXXX to a location YYYY. Perform the block move in reverse order as well
2	ALP to find sum of 10 data bytes stored in consecutive memory locations
3	ALP to find largest of 10 data bytes stored in consecutive memory locations
4	ALP to find smallest of 10 data bytes stored in consecutive memory locations
5	ALP to find sum of two 16 bit data stored in four consecutive memory locations
6	ALP to convert binary number to decimal and decimal to binary
7	ALP to convert decimal to binary and binary to ASCII codes
8	ALP to find sum, difference and product of two 8bit data
9	ALP to generate a square wave through 8255 Ports
10	ALP to glow an LED on receiving an interrupt signal
12	ALP to display decimal number on seven segment display
13	ALP to control DC motor / stepper motor speed through pulse width modulation
13	ALP to rotate a DC motor in clockwise and anti clockwise directions

Suggested Reading:

1. Electronic Devises & Circuits Theory – Boylestad & Nashalsky. Pearson Education
2. Modern Digital Electronics –R.P. Jain, TMGH
3. Fundamentals of Microprocessor – B.Ram. Dhanpat Rai
4. Introduction to Microprocessors – Gaonkar,New age Publication

SECOND SEMESTER (ECT/MEAC)

ECT 2014/MEAC2014: Semiconductor Device Fabrication Technology & Linear Electronic Circuits (100 marks) (L= 03, T = 01, P= 0)	
Course Outcomes: By the end of these courses, student will be able to ▪ Explain semiconductor crystal growth process ▪ Explain fabrication processes of semiconductor devices and integrated circuits (ICs) ▪ Analyze small signal and large signal equivalent circuit of BJT, JFET & MOSFET ▪ Design of rectifier, filter, amplifiers, comparators and many other circuits for analog signal processing based on discrete as well as ICs **(Course instructor should introduce use of PSPICE/Other available software package as part of the course on Linear Electronic Circuits)**	
A) Semiconductor Device Fabrication Technology (30marks)	
Unit-1	**Thin Film:** Basic definitions- thin and thick films, properties of thin films, thin film deposition methods- PVD, CVD, Epitaxy theory of nucleation and growth in thin films; VPE, LPE, MOCVD, MBE techniques Growth of multilayer structure, defects; diffusion, method of control and measurement of film thickness, structure, optical, electrical and mechanical characterization of thin films metallic, semi conducting and insulating films; non crystalline films; various applications of thin films. (**10 marks**)
Unit-2	**IC Processing:** Introduction to I.C s – Definition, scale of integration, types-monolithic, hybrid, thick & thin films; capacitance & resistance formation in ICs , idea of fabrication (silicon planar technology). Fabrication of diode, BJT, FET & MOSFET in ICs; Bulk semiconductor growth: zone refining technique Czochralski growth, vertical and horizontal Bridgman technique. Wafer preparation, oxidation, diffusion, ion implantation, metallization, pattern definition, encapsulation, lithography: advanced processing technique, electron beam lithography, soft x-ray lithography various types of etching plasma etching (**10 marks**)
Unit-3	**Fundamentals of low dimensional semiconductor structures:** Moore's law: Transition from microelectronics to nanoelectronics, low dimensional semiconductor structures-quantum well, quantum wire, quantum dots, electron transport in nanostructures, metal nanoparticles. Synthesis & characterization of nanomaterials: Template-based synthesis, Lithographic techniques, Nonlithographic techniques. Chemical Characterization & Structural Characterization. Carbon Nanotubes (CNTs) & Graphene, application of nanomaterial (**10 marks**)
B) Linear Electronic Circuits (70 marks)	
Unit -1	**Diode circuits:** Review of pn diode junction operation, diode testing with multimeter, diode specifications; diode biasing, load line analysis, series and parallel connection of diodes, rectifier circuits & zener diode based voltage regulator, clipper and clamper circuits, voltage multiplier circuits; Logic gates design with diodes (**10 marks**).
Unit -2	**BJT circuits:** Review of BJT operation and, BJT testing with multimeter, BJT specifications; BJT biasing techniques, Q-point and stability factor; BJT modeling: r_e -model, *h*-parameter model, hybrid π-model; small signal analysis of BJT amplifiers at low and high frequencies – determination of input impedance, voltage gain, current gain and output impedance of BJT amplifiers in CE, CB and CC configurations; Darlington pair and feedback pair BJT amplifiers;

	multistage BJT amplifiers, tune amplifiers. Switching circuits and logic gate design with BJT (**10 marks**).
Unit-3	**JFET and MOSFET circuits:** Review of JFET & MOSFET operation, device specifications; JFET & MOSFET biasing techniques and biasing techniques; Transconductance model of JFET and MOSFET; small signal analysis of JFET & MOSFET amplifiers at low and high frequencies – determination of input impedance, voltage gain, current gain and output impedance of the amplifiers in CS, CG and CD configurations; multistage JFET & MOSFET amplifiers. Basics of switching circuits design with JFET and MOSFET (**10 marks**).
Unit-4	**Frequency response of amplifiers:** Amplifier gain in Decibels, frequency response plots – magnitude response and phase response, -3dB amplifier bandwidth determination from Bode plots, gain-band width product, square wave testing of amplifiers; comparison between performance of BJT, JFET and MOSFET amplifiers at high frequencies; gain cross over and phase crossover frequency, transfer function of amplifier – location of poles and zeros, stability criterion (**10 marks**).
Unit-5	**Power amplifiers:** Classification of power amplifiers; design and analysis of class A, B, AB, C amplifiers – determination of conversion efficiency, signal distortions in power amplifier; heat sink requirement and power transistor specifications; Qualitative study of class D, E & F amplifiers. Case study of commercially available power amplifier ICs for audio and RF applications (**10 marks**).
Unit-6	**Differential amplifier and OP-AMP:** Differential amplifier terms and terminologies, design and analysis of differential amplifier with BJT, JFET & MOSFET, differential and common-mode operations, Current mirror circuits and their role inside OP-AMP circuitry, Op-AMP: review of ideal and real characteristics of OP-AMP, case studies of OP-AMP 741; OP-AMP circuits – analog computation, logarithmic and anti-logarithm amplifier, precision rectifier, comparator, Schmitt trigger, voltage to frequency converter, instrumentation amplifier, voltage follower, active filter circuits, differentiator, integrator (**10 marks**).
Unit-7	**Feedback and oscillator circuits:** Types of feedback, Feedback topologies, effect of feedback on amplifier performance; Barkhausen conditions for sustain oscillation, types of oscillator circuits – sinusoidal and non-sinusoidal oscillators; BJT based multivibrators, design of RC-phase-shift oscillator, Colpitt and Heartly oscillators with transistors and OP-AMP. Tune oscillators and crystal oscillators. Qualitative study of oscillator ICs, VCO & PLL ICs (**10 marks**).

Suggested Reading:

Semiconductor Device Fabrication Technology:

1. Material Sience of Thin Films – M.Ohring, New Age Academic Pub.
2. VLSI fabrication principles -Gandhi. S.K. Wiley
3. VLST Technology – S.M.Sze, Wiley
4. Integrated Circuit and fabrication - Elliot, McGrawhill publication

Fundamentals of Low dimensional Semiconductor Structures:

1. Fundamentals of Nanoelectronics – George, W. Hanson, Pearson

Device design:

1. Electronic devices & circuit theory- Boylestad & Nashalsky, PHI
2. Electronic Device & Circuit - Millman-Halkias , Tata McGraw Hill
3. Microelectronic Circuits - Sedra & Smith, Oxford press
4. Electronic Principles –Malvino, TataMcGraw Hill
5. Solid State Devices-Streetman, PHI

ECT 2024/MEAC2024: Electromagnetics & Microwave-I (100 marks) (L= 03, T = 01, P= 0)

Course Outcomes: By the end of these courses, students will be able to

- Explain Maxwell equations and theories of electromagnetic wave
- Design transmission lines, waveguides and antenna
- Illustrate microwave devices, their working and applications

A) Electromagnetics (50 marks)

Unit-1	**Fundamentals of electromagnetic theory**: Formalism of Maxwell equations – differential & integral forms and their interpretations, boundary value problems based on Maxwell equations (**5 marks**).
Unit-2	**Uniform plane waves:** Uniform plane waves in time domain in free space, sinusoidal time-varying uniform plane waves in free space, wave equation and solution for material medium, uniform plane waves in Dielectrics and conductors, Poynting Vector, Power dissipation and energy storage (**10 marks**)
Unit-3	**Transmission lines-I (time domain analysis):** TL equations and solutions, Determination of line parameters, line terminated by resistive load, bounce diagram,TL discontinuity, Reactive and nonlinear resistive elements(**5 marks**).
Unit-4	**Transmission lines-II (sinusoidal steady state analysis)**: short circuited line, Line terminated by arbitrary load, TL line matching; Quarter wave transformer matching, single stub matching, Double stub matching, the smith chart and applications, the lossy line (**10 marks**)
Unit-5	**Metallic Waveguides and resonators:** uniform plane wave propagation in an arbitrary distinction, TE and TM waves in a parallel-plate waveguide Rectangular waveguide and cavity Resonator, Losses in Waveguides and Resonators(**10 marks**)
Unit-6	**Electromagnetic Principles for Photonics:** Reflection & Refection of plane waves, Dielectric slab guide, Ray tracing and graded index guide, optical fiber (**5 marks**)
Unit-7	**Antennas:** Hertzian dipole, Radiation resistance and Directivity, Linear Antennas, Antenna Arrays, Aperture Antennas, Receiving properties, Antenna temperature, signal to noise ratio (**5 marks**)

B) Microwave-I (50 marks)

Unit -1	**Limitations of conventional tubes**: Limitations of conventional vacuum tubes at VHF and UHF; Bandwidth limitation effects, Tube reactance effects and transit time effects; Remedies (**10 marks**).
Unit -2	**Klystron amplifier:** Introduction to Klystron amplifier, Velocity modulation and bunching of electrons; L-cavity Klystron amplifier; operation and analysis; power and efficiency; Multi- cavity Klystrons, Reflex Klystrons, operation and analysis: Electronic admittance; Electronic tuning; Power output and efficiency; Applications (**15 marks**).
Unit-3	**Magnetron**: Principle of Magnetron, Linear and cylindrical magnetron, Hull cutoff voltage and Hull cutoff frequency, Basic principle of inverted magnetron (**15 marks**)
Unit-4	Avalanche diode, Gunn affects diode, RWH theory, modes of operation and use of Gunn diode as microwave generator, Travelling Wave Tubes (TWT) (**10 marks**)

Suggested Reading:

Electromagnetics:

1. Elements of Engineering Electromagnetics – N.N. Rao, Pearson Education
2. Field and Wave Electromagnetics – D.K. Cheng, Pearson Education

3. Electromagnetic Waves & Radiating systems – Jordan & Balmain, TMGH
4. Electromagnetic Field Theory and Transmission Lines-Raju, Pearson Education

Microwave-I:
1. Microwave Devices and Circuits- Samuel Y. Liao, Prentice Hall of India
2. Microwave Engineering-Passive Circuits- Peter A. Rizzi, Prentice Hall of India

ECT2034/MEAC2034:Power Electronics & Control System (100 marks) (L= 03, T = 01, P= 0)

Course Outcomes: By the end of these courses, students will be able to

- Explain operation of power electronic devices
- Design power electronic circuits and systems
- Explain theory of control system
- Modeling, design and working of control systems
- Illustrate engineering applications of control system

(Course instructor should introduce use of MATLAB as part of the course on Control System)

A) Power Electronics (50 marks)	
Unit-1	**Introduction to power electronics:** Basic terminologies, definitions, comparison of conventional and power electronics, calculation of power, power factor, single/three phase, star and delta connections, power measurement techniques and equipment, heating effect, noise factors, shielding, protections, circuit breakers, ground leakage detection, MCBs ELCBs, etc. Single phasing preventers**(15 marks).**.
Unit-2	**Power electronics circuits:** Controlled rectifiers and filters: Single phase half wave and full wave-Semi-converter and full converter, Dual converter, Three phase half wave, semi and full wave converter, three phase dual converter, simple LC and cascaded LC filters, Power factor improvement. Inverters: Principle of operation, voltage driven inverters, current driven inverters; Choppers: Basic principles, Type A, B and C choppers Series and parallel turn- off choppers, Morgan choppers and Jones choppers.Triggering and protection circuit: Thyristor firing, circuit-using transistor, UJT, PUT etc. thyristor gate protection circuit, di/dt and dv/dt protection for thyristors **(15 marks).**
Unit-3	**AC power supply systems:** CVTs, Stabilizers, tap changers, UPS types (on-line and off line) etc. **(5 marks).**
Unit-4	**Special application DC power supplies:** CVCC, voltage mode and current mode SMPS, Tracking and fold back systems, Low voltage, low current, high voltage and high current power supplies, SMPS for computers **(15 marks).**
B) Control System (50 marks)	
Unit -1	**Concepts of closed -loop and open-loop systems:** Importance and Application of Control System; Conceptual Block diagram of a control system and types- open loop and closed loop, Continuous and discrete data systems, Feedback theoryRemedies **(10 marks).**
Unit -2	**Representation of feedback control system:** Block diagram, signal flow graphs, Mason's gain formula; Transfer function concept- Time and frequency domain analysis of first and second order systems to step, ramp and other inputs; error analysis, Types of systems**(10 marks).**
Unit-3	**System Stability:** Routh Hurwitz stability criteria, Root locus, Nyquist criteria, Relative and absolute stability; Polar and Bode Plot, Gain and phase margins**(10 marks).**
Unit-4	**Discrete Control Systems & Control System Design:** Z-transform, Simulation diagram and flow graphs. Effects of proportional, integral and derivative control, Discrete Vs Continuous control systems**(10 marks).**.
Unit-5	**State Variable Analysis:** Importance of state variable analysis; Definition of state, state space, state vector; SV representation of physical systems and electrical networks; Eigen value and eigen vector; Determination of transfer function using SVA; Resolvent Matrix and State transition

matrix; Solution of homogeneous and non-homogeneous systems using SVA**(10 marks).**

Suggested Reading:

Power Electronics:

1. Power Electronics –Rashid, PHI
2. Power Electronics-P.C. Sen, TMH Ltd.
3. Thyristor engineering-M.S. Bedi, Khanna publications.
4. Thyristors and their applications-N.Rammurthy

Control systems:

1. Control Systems Engineering - I.G. Nagrath, M. Gopal; Wiley Eastern Ltd.
2. Automatic Control Systems- B.C. Kuo, Prentice-Hall of India.
3. Modern Control Engineering- K. Ogata, Prenticd-Hall of India
4. Control System – S. Ghosh, Pearson Education
5. Control System Engineering- Bhattacharjya- Pearson Education

ECT2044/MEAC2044: Communication System (100 marks) (L= 03, T = 01, P= 0)

Course Outcomes: By the end of this course, students will be able to

- Explain signal theory, benefit of modulation and demodulation processes employed in electronic communication systems
- Design various modular units of communication systems used in different fields
- Explain Sources of noise and effect of noise in communication systems

(Course instructor should introduce use of MATLAB as part this course)

Unit-1	**Basic signal theory:** Fourier transform, Convolution theorem, statements of time & frequency domain convolution. Power spectral density, Energy spectral density. Parseval's theorem **(5 marks).**
Unit-2	**Communication system:** Block diagram; Requirements of modulation. Superheterodyne receiver-AGC; .Types of modulation-AM, PM, FM **(5 marks).**
Unit-3	**Amplitude modulation:** Basic principle of DSB, SSB (phase discrimination method) and VSB systems, Modulators & demodulators. Modulators: ring modulator, balanced modulator & BJT modulator; Demodulator: diode detector, envelope detector & BJT detector **(20 marks).**
Unit-4	**Angle modulation:**Phase modulation & frequency modulation, Sinusoidal FM, frequency spectrum for sinusoidal FM, Average power, Sinusoidal PM, Equivalence between FM& PM, elementary idea of direct(Armstrong) & indirect modulator(VCO method), elementary idea of demodulators(discriminator, limiter,PLL & ratio detector) **(20 marks).**
Unit-5	**Noise:** Different types of noise, Thermal, shot, flicker noise, Noise figure, Equivalent noise temperature; Noise in DSB, SSB, FM systems **(15 marks).**
Unit-6	**Pulse Modulation:** Sampling theorem, Nyquist criteria; PAM- generation and recovery; PCM,-stages likesampling, quantization, encoding, regeneration; noise considerations; Multiplexing: Frequency division multiplexing (FDM) & Time division multiplexing (TDM) **(15 marks).**
Unit-7	**Television:** Monochrome TV transmitter and receiver ;picture elements, different types of scanning and scanning standards , Interlacing ; camera tubes-iconoscope, image orthicon & vidicon; synchronization-horizontal and vertical synchronization pulses; blanking- horizontal & vertical ; bandwidth & channels; colour TV-transmitter & receiver, picture tube- trinitron , CCD,generation of color **(10 marks).**
Unit-8	**Informatics:** Telephony, Fax and Telegraph – basic principles and applications; Radar – Basic principles, range calculation, types and application **(10 marks).**

Suggested Reading:

1.Communication Systems-B.P. Lathi, Willey Eastern
2.Radio Engineering, Vol.II-G.K. Mittal, Khanna Publishers
3.Electronic Communications-Schoenbeck, PHI
4.Electronic Communications Systems-Kennedy, TMGH
5.Communication Systems-Simon Haykin, John Wiley ;
6.Electronic Communication-Roddy, Coolen, PHI
7.Monochrome & Colour television-Gulati,Wiley Eastern
8.Communication System Engineering-Prokais, Pearson Education;

ECT 2054/MEAC2054:Optoelectronics & Instrumentation (100 marks) (L= 03, T = 01, P= 0)

Course Outcomes: By the end of these courses, students will be able to

- Explain physics and operation of basic optoelectronic devices
- Design basic optoelectronic circuits
- Design basic electrical and electronic equipments used in test and measurement application
- Illustrate working of advanced test and measurement instruments
- Design and working principles of sensors and transducers

***Course instructors should introduce use of**

- **OptiSpice/Other available software as part of the course on Optoelectronics**
- **Virtual instrumentation with LabVIEW as part of the course on Instrumentation**

A) Optoelectronics (50 marks)

Unit-1	**Review of semiconductor physics:** Direct and indirect band gap semiconductors, energy band diagrams and optical processes in semiconductors - optical absorption and carrier transitions; carrier recombination and generations **(5 marks).**
Unit-2	**Light emitting diode (LED) and Laser**: LED materials, physics of homojunction and heterojunction LEDs, quantum dot LEDs. Radiation patterns of LED – surface and edge emitting diodes, super luminescent LEDs. LED characteristics- internal and external quantum efficiency, spectral width, thermal effects, modulation bandwidth, power-bandwidth product, reliability. Basics of OLED and organic materials for OLED. Basics of laser: stimulated emission and spontaneous emission, population inversion, active medium, optical cavity and optical feedback, and pn-junction laser diodes – homojunction and heterojunction lasers, single quantum well (QW) and multiple QW laser diodes, DFB, VCSEL laser diodes; thermal effect on laser threshold current, spectral purity **(15 marks).**
Unit-3	**Photodetectors (PD):** PD materials, physics of pn junction PD, p-i-n PD, avalanche PD, long wavelength detection PD and their mode of operations. PD characteristics- Dark current, responsivity, response times, electrical and optical bandwidth, angular response of PD, noise, noise equivalent power. PD's quantum limit of light detection in pulsed optical communication; basics of photomultiplier tubes; Solar cells: I-V characteristics and spectral response, materials and fabrication of solar cells, Quantum Dot solar cells **(10 marks).**
Unit-4	**Optical fibers:** Theory of dielectric waveguide ; light coupling to fibers and propagation principle – Total internal reflection; fiber classifications based on mode and refractive index profile; Numerical aperture, acceptance angle, light coupling to optical fibers, power loss inside the fibers, pulse dispersion, dispersion compensated fiber, polarization maintain fiber; fiber amplifier, fiber splicing, wavelength multiplexer & demultiplexer; OTDR, optical power budgeting in fiber links **(15 marks).**
Unit-5	**Luminescence and electro-optics and magneto-optics:** Luminescent materials – fluorescence & phosphorescence phenomena, Stokes shift; luminescent display devices based on CRT, LED, plasma, LCD, and OLED. **(5 marks).**

B) Instrumentation (50 marks)	
Unit -1	**Instrumentation scheme & error:** Electronic instruments & their characteristics, a generalized instrumentation scheme, classification of instrumentation error & their statistical behavior; Basic instrumentation circuits- Operational amplifier application, Instrumentation amplifier, Noise measurements and noise reduction techniques **(10 marks).**
Unit -2	**AC & DC meters:** Measurement of current, voltage & power at audio & radio frequencies; electrostatic rectifier & thermocouple type instruments; advantage of electronic voltmeters, vacuum tube voltmeters(diode type only); True RMS-Responding voltmeter, digital voltmeter, Q meter, power factor meter; DC ammeters; ohmmeter, multimeter-analog & digital **(10 marks).**
Unit-3	**Signal generators:** Basic circuits for generation of square wave & triangular wave. Block diagram of laboratory square-wave & pulse generator. Function generator (block diagram), sine wave generation by a sine shaper (qualitative idea); sweep generator **(10 marks).**
Unit-4	**Oscilloscopes & signal analyzers:** Motion of charged particles in electric & magnetic fields in simultaneous electric & magnetic field (cross & parallel) Block diagram of CRO, CRT: construction principles of focusing & deflection of electron beam, CRT screens vertical deflection system, vertical amplifier, delay line, horizontal amplifier, synchronization; CRO probes, trigger circuits, application of CRO in measuring voltage, frequency, phase; Digital oscilloscope: DSO & DPO architecture and operations. Basics of logic analyzer, distortion analyzer, wave analyzer, spectrum analyzer and their applications **(10 marks).**
Unit-5	**Transducers & digital instrumentation:** Definition, types-active & passive, analog & digital; active-thermocouple & piezoelectric transducers, passive-potentiometric devices, thermistors, LVDT; Basic idea-displacement & temperature transducer; Digital measurement techniques, Time and frequency measurements, Interface of instruments with computer, Virtual Instruments. Digital transducers; Sensors- conventional and bio-sensors **(10 marks).**
Suggested Reading:	
Optoelectronics:	
1. Optical Fiber Communications - Gerd Keiser, Mc.Graw hill 2. Introduction to Opto- Electronics - J.Wilson and JFB Wilson, PHI 3. Fiber optic communication Technology – M.Scheiner, Pearson	
Instrumentation:	
1. Electrical & Electronic Measurements – A.K. Sawhnay, Dhanpat Rai Publications 2. Electronics Measurements and Instrumentation- B.E. Oliver and J.M. Cage, McGraw Hill 3. Instrumentation, Measurement and Feedback- B.E. Jones, Tata McGraw Hill 4. An Introduction to Error Analysis - J.R. Taylor, Univ. Science Books 5. Statistical Analysis of Experimental Data – J. Mandel, Dover Publication	

ECT 2064/MEAC2064: Laboratory-II (100 marks) (L=0, T=01 P=03)

Course Outcomes: By the end of this course, students will be able to

- Perform experiments with microwave device
- Model and simulate control systems with soft-computing tools
- Design and study of basic communication circuits
- Design and study of basic power electronic circuits

A. Microwave, Control System and Power Electronics (50 marks)

Microwave (By using experimental set-up):

1. Study of I-V characteristics of Gunn diode
2. Measurement of SWR and reflection coefficient of a transmission line
3. Study of Klystron tube
4. Study of radiation pattern and -3dB bandwidth of a given antenna
5. Determination of cut-off frequency of a rectangular waveguide

Control System (By using Simulation tools):

1. To plot poles and zeros of a system by using its transfer function
2. Study of rise time, peak time and settling time of a second order system
3. Study of the performance of PID control system
4. Study of the stability of a given system by using its transfer function

Power Electronics(By using experimental set-up/Simulation tools):

1. Study of I-V characteristics of DIAC
2. Study of I-V characteristics of SCR
3. Study of I-V characteristics of TRIAC
4. Study of I-V characteristics OF UJT

B. Communication System (50 marks) (By using experimental set-up and or/ Simulation tools):

1. Design of an AM modulator using diode/ BJT/ FET.
2. Design of an AM demodulator using diode / BJT/ FET
3. Design of an FM modulator using diode/ BJT/ FET.
4. Design of an FM demodulator using diode / BJT/ FET
5. Study of Phase modulation / pulse modulation using trainer kits.
6. Generation of PCM using discrete components/ trainer kits/ software.
7. To determine bending loss of optical fiber
8. To determine numerical aperture of optical fiber
9. To study transmission and detection of analog signals through optical fiber

THIRD SEMESTER (ECT)

ECT 3014: Mechatronics and Electronic System Design (100 marks) (L=03, T=01 P=0)

Course Outcomes: By the end of these courses, students will be able to

- Describe basic components of mechatronics system
- Elaborate working principle of Electro-mechanical system
- Modeling of Electro-mechanical system
- Illustrate different parts of CNC, CIM and robotics system
- Design and Simulation of Electronics Circuits using PSPICE Software
- Design of PCB Layout by Diptrace software

- **Course instructor should introduce PSPICE simulator & PCB Design software like Dip-Trace as part of the course on Electronic System Design**
- **Discrete component as well as IC based circuits should be considered for circuit design**
- **Design methodology should address real practical problems and applications rather than ordinary theoretical studies**

A) Mechatronics (50 marks)	
Unit-1	**Introduction :**Evolution of mechatronics, an overview of mechatronics, scope of mechatronics
Unit-2	**Electronics for Mechanical System:** Electrical components and Electronic Devices, Basics of Digital Technology, Transducers and Sensors, Signal conditioning theory, circuits and systems **(10 marks)**
Unit-3	**Actuators:** Types of actuators - electromechanical actuators, fluid power actuators and active material based actuators. Mechanism- Bearings, Belt, Chain, Pulleys, Gears, Rack and Pinion, Slider and Crank, Cams and Followers, Four-bar linkages **(10 marks)**
Unit-4	**Modeling:** Introduction, System modeling, Mechanical System, Electrical System, Fluid system, Thermal systems, Translation mechanical systems with springs, damper and mass, Rotational mechanical system with spring, damper and mass, modeling electric motor, modeling chamber filled with fluid. **(10 marks)**
Unit-5	**CNC Systems:** Principle of numerical control, types and features of CNC System, Constituent parts of CNC machines and assembly techniques, configuration, Interfacing, Monitoring and diagnostics. **(10 marks)**
Unit-6	**CIM:** Definition, elements of CIM, its nature and role, CIM hardware and software, requirement of a computer to be used in a CIM system; Robotics: Definition, types of robots, performance capabilities, programming robots, Robot operation and application, Integration of industrial robots into CIM system, Expert system in CIM **(10 marks)**
B) Electronic System Design (50 marks)	
Unit -1	**Introduction:** Review of voltage source, current source, passive and active circuit components; nodal and mesh analysis of DC and AC circuits - hand calculation & simulation in PSPICE for verification. Electronic system design process: generation of functional block diagram and modular break-up; modular design flow, functional and performance testing; estimation of design cost, reliability, failure rate. Grounding, shielding and isolation techniques for electrical and electronic circuits **(5marks)**.
Unit-2	**Linear Circuit formulation:** Time domain and frequency domain techniques for circuit design and analysis, transfer functions, Pole-zero analysis of electronic circuits, Bode plots **(5 marks)**.
Unit-3	**Analog system design:** Analog filters, voltage and power amplifiers for processing biomedical signals, audio and high frequency signals, oscillators, voltage to frequency & frequency to voltage converters. Regulated DC power supply systems, voltage multipliers, DC-DC converters. Simulation of the above circuits with PSPICE (DC sweep/AC analysis, Transient Analysis etc.). **Digital systems design:** clock generators, encoder & decoder, parity checkers, programmable counters, unidirectional and bidirectional data registers, sequence generator, implementation of

	logic circuits with multiplexers; multi-vibrator applications, seven segment driver, pulse counters, frequency dividers, frequency multipliers, frequency to digital converters, time to digital converters, pulse discriminators, digital logic probes, digital stop watch, LED & LCD based display. Simulation of the above digital circuits with Circuit Maker/Multisim **(15 marks)**.
Unit-4	**Communication circuits:** AM and FM tuning circuits, mixing and heterodyning circuits, modulator and demodulator circuits for AM and FM signals, AGC and equalizer circuit of radio receiver. Pulse modulator, ASK, FSK, PSK modulator and demodulator circuits. Simulation of the circuits & systems in PSPICE. **(10 marks)**
Unit-5	**Data acquisition system:** Sensor and transducer circuits for measuring temperature, light intensity, humidity and biomedical signals, signal conditioners, sample and hold circuits, single channel and multichannel ADCs & DAC circuits. Interfacing ADC and display devices to 8085 microprocessor for data acquisition (0804/0808 and interfacing with 8085), driver circuits of DC and AC motors; microprocessor based DC motor speed control; Basics of PC based DAQ system design **(10 marks)**.
Unit-6	Schematic drawing and PCB design with CAD software, PCB fabrication and component soldering and de-soldering techniques. Study of functional diagrams of radio receivers & TV and personal computers, AC voltage stabilizers, inverters, UPS; electronic choke, electric fan, induction cooker, electric iron, remote control, grinding machines etc. Maintenance and troubleshooting techniques for electronic and electrical appliances used in domestic applications and laboratories; Domestic electric wiring techniques, safety measures against electrical shocks **(5marks)**.

Suggested Reading:

Mechatronics:

1. Mechatronics - W. Bolton, Addition –Wesley Longman Ltd.
2. Mechatronics - Denny K. Miu, Springer- Verlag
3. Mechatronics - Principles, concepts and Application TMH
4. CAD/ CAM/ CIM -R. Radhakrishnan, S. Subramanyan

Electronic System Design:

1. Art of Electronics – Horowitz and Hill, Cambridge University Press
2. PSIPCE using ORCAD - Rashid, PHI
3. PC based Instrumentation – N. Mathivanan, PHI
4. Microprocessors, PC hardware & Interfacing – N. Mathivanan, PHI
5. Monograph On Electronics Design Principles – N.C.Goyal & Khetan, Khanna Publishers.

ECT3024: Signals & Systems and Digital communication system (100 marks)
(L=03, T=0, P=01)

Course Outcomes: By the end of these courses, students will be able to

- Analyze and identify different types of signals
- Explain Fourier series and Fourier spectra
- Determine response of LTI system to different signal inputs
- Explain different digital modulation schemes
- Design of digital communication system with soft computing tools.

(The course instructor should introduce MATLAB/Other available tool as part of this course)

A) Signals & System (50 marks)

Unit-1	**Signal and System classification:** Definition of Signals and types like random and deterministic, continuous and discrete, Periodic, aperiodic; even-odd; exponential, sinusoidal; unit impulse & unit step functions; Definition of System and types- linear, causal, time-variant, stable, with memory and related types; Sampling theorem- review only **(10 marks)**
Unit-2	**Linear time invariant [LTI] system:** Representation of discrete time signals in terms of impulses; convolution; convolution sum representation of LTI systems; properties of LTI systems-

	commutative, distributive, associative; LTI systems with & without memory, causality, linearity, stability of LTI systems; Unit impulse response of an LTI system; Interconnection of LTI systems; Correlation, cross correlation and autocorrelation **(10 marks)**
Unit-3	**Discrete Fourier Transform:** Definition, properties; linear& non-linear phase; DFT-definition & properties; Discrete linear and periodic convolution; IDFT. Relation of DFT to other transformation; FFT - Decimation in time and frequency ; Radix-2 and radix-4 algorithms; Spectrum analysis using FFT; Discrete power spectral density **(10 marks)**
Unit-4	**z-transform:** Definition, properties; inverse z-transform; relation with other transforms; Convolution, correlation- cross correlation and autocorrelation **(10 marks)**
Unit-5	**Digital Filter Design:** Representation of 1^{st} & 2^{nd} order recursive & non-recursive filters; Digital- filter realizations from analog forms using impulse invariance, bilinear transforms; Low-pass, High- pass Filters FIR Filter, Low pass, High pass IIR filters, Comb filters; Filter design by windowing method **(10 marks)**
B) Digital communication (50 marks)	
Unit-1	**Random Process:** Probability theory, random variable, statistical averages, transformation of random variables, random process, stationarity, mean, correlation and covariance, ergodicity, transmission of a random process through a linear filter, power spectral density, Gaussian process **(10 marks)**
Unit-2	**Pulse modulation:** Sampling theorem, pulse analog modulations (PAM), Shaping of the transmitted signals spectrum, Equalization, Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM), Quantization; PCM- Limitations of PCM; Companding; DM, DPCM- preliminary idea; coding speech at low bit rate, APCM; CODEC **(10 marks)**
Unit-3	**Signal vector analogy:** Similarity of signals and vectors including calculation of error coefficient; Geometric interpretation of signals; matched filter; inter symbol interference, Nyquist criteria for distortion less transmission through a baseband channel; equalization- tapped delay line and adaptive (LMS); passband transmission model- Gram Schmidt orthogonalization; Coherent detection of signals; Correlator receiver; Detection of signals with unknown phase **(10 marks)**
Unit-4	**Digital Modulation techniques:** Amplitude shift keying (ASK), Frequency Shift Keying (FSK), phase shift keying (PSK), Dual Phase Shift Keying (DPSK) schemes, Coherent binary PSK/ FSK; Coherent quadri- PSK; Coherent minimum shift keying; differential PSK Comparison of digital modulation schemes, M-array signaling scheme; QAM; Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM). **(10 marks)**
Unit-5	**Spread Spectrum modulation:** Definition; types-direct sequence & frequency hoping; pseudo-noise generation; Idealized model of a spread spectrum modulator; DS- & FH-spread spectrum modulation generation and detection; application; CDMA, GSM **(10 marks)**

Suggested Reading:

Digital communication:

1. Communication Systems - Simon Haykin, Wiley Eastern
2. Digital & Data Communication- Miller, Jaico Publisher
3. Digital Communication - Simon Haykin, Willey Eastern
4. Communication System Engineering- Proakis, Pearson Education
5. Digital Communication- B. Sklar, P.K. Ray, Pearson Education

Signals & Systems:

1. Signals & Systems - Oppenheim & Willsky, PHI
2. Digital Signal Processing - Mitra,Tata McgrawHill
3. Digital Signal processing - Proakis, Pearson Education
4. Digital Signal processing -Salivahanan, Vallavaraja, Gnanapriya, TMGH
5. Digital Signal Processing -Bandopadyaya, PHI
6. Signal, System and Transforms - Philip, Pearson Education

ECT 3034: Microprocessor-II & Microcontrollers (L=03, T=0, P=01)

Course Outcomes: By the end of this course, students will be able to

- Compare difference between Microprocessor and Microcontroller systems
- Explain Architecture of microprocessor and microcontroller
- Elaborate instruction sets and addressing modes of microprocessor 8086 and Microcontroller 8051
- Design of hardware circuit using 8051microcontroller

(The course instructor should introduce 8086 & 8051simulator to the students as part of this course)

A) Microprocessor-II (30 marks)

Unit-1 **8086 Processor-Architecture, Pin Diagrams and Timing Diagrams**
Van Neumann and Harvard Architecture, CISC and RISC Processors, Microprocessor based computer system, Architectural block diagram of 8086 Microprocessor, Register Organization-General purpose registers, segment registers, PSW, index and pointers registers, Pin diagram and signal Descriptions, Physical Memory Organisation, General Bus operation, I/O Addressing capability, Minimum Mode 8086 system and Timings, Maximum mode 8086 system and Timings **(10 marks)**.

Unit-2 **Instruction Set and Addressing Modes of 8086**
Instruction set of 8086 – Classification of 8086 Instructions - Data transfer instructions – Arithmetic Instructions –Logical instructions –Branching instructions – Bit Manipulation Instructions, Different addressing modes of 8086, Assembling and running an 8086 program – Structure of Assembly Language –Assembler directives**(10 marks)**.

Unit-3 **Advanced Processors:** Introduction to architecture of Intel 80186, 80286, 80386 & 80486**(10 marks)**.

B) Microcontrollers (70 marks)

Unit-1 **8051 Architecture**
Introduction to MCS -51 Family microcontrollers, Architectural block Diagram, Comparison of Microprocessor and microcontroller, Pin diagram and Pin functions, General purpose and special purpose registers, Oscillators and clock circuit, Reset Circuit, I/O Port Circuits, Memory Organizations, Program memory and data memory **(5 marks).**

Unit-2 **8051 Assembly language programming:** Programming model of 8051, Addressing modes, data transfer instructions, I/O Port programming, Arithmetic and Logical instructions, Bit level instructions, branching instructions (Jump and loop Jump and call), Concept of stack, subroutine and related instructions, writing programs (like time delay using loop, data conversions HEX to ASCII, BCD to ASCII, use of look up table etc)in assembly language 8051**(15 marks)**

Unit-3 **8051 Programming with embedded C:** Embedded C – variables & data types, branching & looping, array & pointers, advanced C functions; Concept of Integrated Development Environment, Editor, Assembler, compiler, Linker, simulator, debugger and assembler directives, working with Edsim51, Keil IDE, Development flow for the Keil IDE **(10 marks)**

Unit-4 **External Memory Interfacing & Timer/Counter and Programming:**
Memory address decoding, interfacing 8031/8051 with ROM/EPROM, RAM; Introduction and function of Timer/Counters, Timer/Counters and associated registers, 8051 Pins for counters, various modes of timer/counter operations, Time delay and external event counter programs in Assembly language/ Embedded C**(10 marks)**

Unit-5 **8051 Interrupts:** Concept of interrupts, polling versus interrupts, Types of interrupts in 8051,

	interrupts control and associated registers, interrupt vectors, Interrupt execution, RETI Instruction, software and hardware generated interrupt, interrupt handler subroutine for timer/counter and serial data transmission/reception in assembly language/ embedded c, Interrupt priority and associated register. **(5 marks)**
Unit-6	**Serial Port and Programming:** Basic of serial communications, RS232 standard, 8051 connection to RS232, serial input/output and associated registers various modes of serial data communication, serial data communication program in assembly language /embedded C **(10 marks)**.
Unit-7	**Microcontroller based systems:** Interfacing of LED's, 7-segment display device, LCD display, DIP switches, push button switch, keyboard, Interfacing of A/D Converter, D/A Converter, Relay, opto isolator, stepper motor and dc motor **(10 marks)**.
Unit-8	**Advanced Microcontrollers:** Introduction to architecture of 16-bit & 32-bit microcontrollers from AVR, ARM, and PIC **(5 marks)**.

Suggested Reading:

A) Microprocessor-II

1. The Intel Microprocessor 8086/ 8088/80286/80386 architecture, programming and interfacing, by Brey, Pearson Education
2. Microprocessor and Interfacing - Douglas Hall, TMGH
3. Microcomputer Systems the 8086, 8088 family Chen, Liu, Gibson, P.H.I.
4. The 80x86 Family: Design, Programming and Interfacing- Uffenbeck, Pearson Education
5. Advanced Microprocessors and Peripherals- By: A. K. Ray and K.M. Bhurchandi
6. Tata McGraw-Hill Publishing Company Limited
7. Introduction to 80X86 Assembly Language and Computer Architecture - Richard C. Detmer Jones and Bartlett Publishers

B) Microcontrollers

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C - Muhammad Ali Mazidi, Rolin McKinlay and Janice Gillispie Mazidi, Pearson India
2. Exploring C for Microcontrollers, A Hands on Approach - Jivan S. Pratab, Vinod G. Shelake , Rajanish K. Kamat and Gourish S. Naik, Springer
3. The 8051 Microcontroller -Kenneth Ayala,Cengage Learning
4. Programming Microcontrollers in C - Ted Van Sickle, LLH-Technology Publishing

ECT 3046(A) : Antenna Modeling & Design (Elective) 100 marks (L=04, T=01, P=01)

Course Outcomes: By the end of this course, students will be able to

- Explain the working of different types of antennas
- Design antennas for different frequencies range of operation
- Draw radiation patterns of antennas

(The course instructor should introduce suitable simulation/modeling tool as part of this course)

Unit-1	**Fundamental Concepts of Antenna :** Physical concept of radiation in single wire, two wire, and dipole, Current distribution on a thin wire antenna. Fundamental Parameters of Antenna: Radiation pattern, Radiation Power Density, Radiation intensity, Directivity, Gain, Antenna efficiency, Beamwidth, Bandwidth, Polarization, Antenna Input Impedance, Elementary idea about self and mutual impedance, Radiation efficiency, Effective aperture, Antenna Temperature. (**10 marks**)
Unit-2	**Radiation from Wires and Loops :** Linear Wire Antennas: Retarded potential, infinitesimal dipole, Current distribution of short dipole and half wave dipole, loop antenna, Far-field, Radiating near-field and reactive near-field region, Monopole and Half wave dipole/ loop antenna (**10 marks**)

Unit-3	**Aperture and Broadband Antenna**: Field Equivalence principle, Rectangular and circular aperture antennas, Slot Antenna, Horn antenna, Parabolic Reflector antenna – Simple Analysis, Types, Radiation Pattern, Gain and Bandwidth measurement of the given antennas. Broadband concept, Log-periodic antennas, frequency independent antennas (**20 marks**)
Unit-4	**Array Antennas** : Array of two point sources, Array factor, n-element linear array with uniform amplitude and spacing, Analysis of Broadside array, Ordinary end-fire array, n-element linear array with non-uniform spacing, Analysis of Binomial and Dolph-Tschebyscheff array, Scanning Array, Super directive array; Yagi Uda antenna, Loop antenna (**25 marks**)
Unit-5	**Microstrip Antennas:** Radiation Mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch Circular patch, input impedance of rectangular and circular patch antenna. Microstrip array and feed network; Application of microstrip array antennas. (**25 marks**)
Unit-6	**Smart Antennas:** Concept and benefits of smart antennas, Fixed weight beam forming basics, Adaptive beam forming (**10 marks**)

Suggested Reading:

1. C.A. Balanis, **Antenna Theory**, John Wiley and sons.
2. J.D. Krauss, **Antenna Theory**, McGraw Hill.
3. K.D.Prasad, **Antenna & Wave Propagation**, Satya Prakashan.
4. E.C. Jordan, **Electromagnetics and radiating systems**, PHI.
5. R.E. Collins, **Antenna and radio wave propagation**, McGraw Hill.
6. M Sachidananda, AR Harish, **Antennas and Wave Propagation**, Oxford University Press, 2007.

ECT 3046(B) : Microwave-II (Elective) (100 marks) (L=04, T=01, P=01)

Course Outcomes: By the end of this course, students will be able to

- Determine different parameters of transmission lines and wave guides
- Design antennas for microwave application
- Explain different microwave frequency bands

(The course instructor should introduce suitable simulation/modeling tool as part of this course)

Unit-1	**Microwave transmission line:** Basic equations, Solution of transmission line equation, Reflection and transmission co-efficient, Voltage Standing wave ratio (VSWR), Line impedance and admittance, Transmission and Reflection co-efficient (**20 marks**)
Unit-2	**Microwave wave guide:** Introduction to microwave wave guides, Solution of wave equation in Rectangular and Circular Wave guides, attenuation in waveguides, propagation modes, TE, TM, and TEM, Wave guide impedance (**20 marks**)
Unit-3	**Microwave antennas:** Antenna action, Basic antenna parameters, Short dipole antenna and its radiation resistance, pattern radiation resistance of ½ dipoles, Broad side and End fire arrays, field of ½ dipole antenna, reflectors. Thin linear antenna, Current and voltage distribution, radiation length, power radiated by linear antenna, radiation resistance of thin linear antenna, Linear array of n isotropic sources of equal amplitude and spacing, Beam width, principle of Yagi antenna, Dish antenna horn antenna, CAD of wire antennas, CAD for medium frequency antennas, computer aided method for measuring impedance of monopole antenna, CAD for small-log periodic dipole arrays. (**20 marks**)
Unit-4	Microwave Frequency bands, Line of sight (LOS) microwave communication link, Ground Reflection co -efficient, Received field strength, variation of received field strength with antenna height, variation with distance, Effect of curvature of earth, Radio horizon, Effective antenna height, divergence factor, in LOS communication link. (**20 marks**)
Unit-5	Propagation Effects for microwave links, Troposcatter Communication link, Fading of Tropospheric signals, Tropopath calculation, propagation impairments at microwave bands; Frequency management, System planning; Link design for LOS and Earth-space paths(**20 marks**)

Suggested Reading:

1. Foundations for Microwave Engineering, Collin, McGraw Hill.
2. Microwave Engineering by Annapurna Das & Sisir K. Das, Tata McGraw Hill.
3. Radio Frequency & Microwave Electronics by Matthew M. Radmanesh, Pearson Education Asia.
4. Telecommunication Engineering Vol.1 & Vol.2 by N.N. Deb, New Age.
5. Telecommunication and Computers by J. Martin, Prentice Hall of India.
6. Microwave Devices and circuits by Samuel Y. Liao, Prentice Hall of India, third edition (1994).
7. Microwave Engineering-Passive Circuits by Peter A. Rizzi, Prentice Hall of India

ECT 3046(C) : Introduction to Nanoscience and Nanotechnology (Elective) (100 marks)
(L=04, T=01, P=01)

Course Outcomes: By the end of this course, students will be able to

- Explain different techniques for synthesize and calibration of nonmaterials
- Describe the current carrier transport processes in nanoelectronic samples
- Model fundamental nanostructures for simulation

Unit-1	**Introduction and historical perspective:** History of development of Nanoscale science, fundamental concepts, nonmaterial's, Examples of interesting nanoscience applications.
Unit-2	**Synthesis of nanomaterials:** Bottom up and top down methods -Template-based synthesis: Electrochemical deposition, Electrophoretic deposition, colloid dispersion, melt or solution filling; Lithographic techniques: Photolithography (Optical, UV, EUV), Electron beam lithography, Ion beam Lithography, X-ray lithography, Dip – pen lithography; Nonlithographic techniques: Plasma arc discharge, Sputtering, Thermal evaporation, Electron-beam evaporation,Chemical vapour deposition, Pulsed laser deposition, Molecular Beam epitaxy, liquid Phase epitaxy, Chemical bath deposition (CBD), Ion beam deposition (IBD), Vapour- Liquid-solid (VLS) technique, Spray-pyrolysis (**15 marks**)
Unit-3	**Characterization tools for Nanomaterials:** Chemical Characterization -UV-Visible spectroscopy, Photoluminescence spectroscopy Raman Spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Secondary Ion Mass Spectrometry (SIMS), Energy Dispersive X-ray Spectroscopy (EDS). Structural Characterization: X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron, Microscopy (TEM), Atomic Force Microscopy (AFM) (**15 marks**).
Unit-4	**Carbon nanotubes & Graphene:** Introduction to Carbon nanotubes & Graphene, Single Wall carbon Nanotube (SWNT), Multi Wall carbon Nanotube (MWNT), Properties of carbon nanotubes & Graphene (**10 marks**).
Unit-5	**Particle in a rigid potential box, Quantum confinement, Low dimentional structures:** Models of semiconductor quantum wells, quantum wires and quantum dots, semiconductor heterostructures & quantum wells, confinement models & 2D electron gas (2DEG), Energy band, transitions in quantum wells, transition & excitonic effects in quantum wire, density of states (DOS) in various dimensions: 1D, 2D & 3D, density of states of quantum well, quantum wire & quantum dots, application of semiconductor quantum dots, Quantum wells & Quantum wires (**20 marks**)
Unit-6	**Electron transport in nanostructures:** Characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Ballistic transport: derivation of Landauer formula, quantum conductance and origin of quantum resistance, Quantum point contact, Resonant tunneling, Coulomb Blockade: coulomb blockade in a nanocapacitor, coulomb blockade in a quantum dot circuit, coulomb staircase(**20 marks**)
Unit-7	**Metal nanoparticles:** Surface Plasmon resonance, core/shell nanoparticles, applications of metal and core/shell nanoparticles(**10 marks**)
Unit-8	**Modeling and simulation:** Modeling, Need of modeling, Modeling of nanoparticle and Simulation, Nanodevice design and Simulation. Simulation Techniques: Finite Element Method based, Finite Difference Time Domain based.Simulation Softwares: COMSOL Multiphysics, CST Microwave Studio. MATLAB: Use of MATLAB in nanoscale simulation. Modeling and Simulation of optical properties of plasmonic nanoparticles for both single layer and core-shell nanoparticles. (**10 marks**)

Suggested Reading:

1. Fundamentals of Nanoelectronics – Gworge.W. Hanson, Pearson
2. Introduction to Nanoelectronics – Mitin, Kochelap and Stroscio, Cambridge Univ. Press

ECT 3054 : Project Work/Dissertation (Phase-I) 100 Marks (T=01 P=03)

Course outcomes: By the end of this course, students will be able to

- Do literature survey and reading research papers
- Formulate research problems and definition
- Demonstrate skills for writing papers & reports

- Students individually or two at the most will carry out a detail study on a topic and implement a related system.
- The study must include literature survey, similar work done previously, proposed work, modifications to be included, applications etc.
- A report is to be prepared and submitted under the guidance of a supervisor. The report should contain design, implementation and experimental details.
- The topics involved in the work should be related to the courses undertaken by the student till this portion of progression under the program.
- The phase I involves primarily the problem definition phase and related literature survey

ECT 3064 : Advanced Circuit Design 100 Marks (T=01, P=03)

Course outcomes: By the end of this course, students will be able to

- Design of advanced electronic circuits
- Model and simulate advanced electronic circuits
- Fabricate and test electronic system

(Students will individually carry out design, fabrication & testing of electronic circuits mainly based on their self study. Laboratory report has to be prepared & submitted)

1. Two stage JFET amplifier.
2. BJT based Class-B power amplifier with loud speaker as load
3. Automatic gain control circuit using JFET as voltage controlled resistance.
4. Wein bridge oscillator with amplitude stabilization using JFET.
5. Regulated power supply with load compensation and short circuit protection.
6. Regulated power supply with foldback current limiting and crowbar protection.
7. Frequency multiplier using Phase locked loop.
8. Differential amplifier using IC transistor array.
9. Stopwatch using TTL ICs.
10. Stopwatch using interrupts on microprocessor kit.
11. TTL IC tester using 8255 on microprocessor kit.
12. Real time clock using 8253 timer on microprocessor kit.
13. Analog signal input and output using A/D and D/A converters interfaced to microprocessor kit.
14. Light detectors and characteristics, Application of a LED/ Laser source to send data and recovery using photo detectors.
15. Switch mode power supply
16. Microprocessor based DC motor speed control with pulse width modulation
17. Microprocessor based control of a simple gear motor based robotic arm
18. Simple AM radio receiver circuit with amplifier & loud speaker as load

19. Simple AM radio receiver circuit with amplifier & loud speaker as load

THIRD SEMESTER (MEAC)

MEAC 3014 : CMOS Circuit Design (100 marks) (L=03, T=01, P=0)

Course outcomes: By the end of this course, students will be able to

- Explain physics of MOS devices, models and device layout
- Design MOS amplifier and digital circuits
- Illustrate application of MOS devices in design of integrated circuits

(The course instructor should introduce suitable simulation tool as part of this course)

Unit-1	**MOS fundamentals:** Two, three, four terminal MOS structures, quantitative analysis of operation of MOS devices, I-V characteristics, C-V characteristics, channel length modulation, transconductance, carrier velocity saturation and other second-order effects. MOS device models - large signal, small signal & high frequency model; SPICE models, MOS device scaling theory **(20 marks)**.
Unit-2	**Device geometry & layout:** Fabrication processes of CMOS & BiCMOS devices. CMOS device layout design rules & guidelines - layout for interconnect lines, via points, I/O lines, grounding, power supply and clock distribution lines; I/O floor planning, routing & Optimization and foundries; basics of CAD software for device modeling, simulation & parameter extraction **(20 marks)**.
Unit-3	**Analog CMOS Circuits:** MOS amplifier topologies, biasing techniques; small signal analysis of common source, common gate amplifiers, source followers, cascade & cascode amplifiers. MOS power amplifiers – conversion efficiency, signal distortions. Feedback in MOS amplifier & stability conditions, transfer function & frequency response of MOS amplifiers, Bode plot, gain & phase margin, Miller effect and compensations. Analysis of MOS current mirror circuits, band-gap voltage reference. MOS differential amplifiers & operational amplifiers. Non-linear analog circuits - PLLs, analog multipliers, squarer, log amplifier, divider, frequency to voltage and voltage to frequency converters. **(20 marks)**
Unit-4	**Digital CMOS Circuits:** MOS device models for switching applications, static and dynamic characteristics of CMOS & BiCMOS logic gates, delay estimation, power dissipation, power-speed trade-off; clocked circuits – flip-flops, counters, shift registers, arithmetic logic circuits, MUX, DMUX circuits, encoders, decoders, MOS memory cells – SRAM, ROM; cross-talk, clock skew, jitter and timing constraints in digital circuits. Basics of programmable logic devices – CPLD, FPGA. **(20 marks)**
Unit-5	**Mixed Signal CMOS Circuits:** Special purpose CMOS circuits such as, DPLL, multi-vibrators, Schmitt triggers and data converters - ADC, DAC **(20 marks)**

Suggested Reading

1. CMOS VLSI design – Circuits and System perpectives, Neil H.E.Weste, David H., A.Banerjee, Pearson Ed.
2. Microelectronics – B. Razavi
3. Design of analog CMOS integrated circuits, B.Razavi, McGraw Hill
4. CMOS circuit design, layout, and simulation, R.J.Baker, Wiley
5. CMOS mixed signal circuit design, R.J.Baker, Wiley.

MEAC 3024: Signals & System and Digital Communication (100 Marks) (L=03, P=01)
Syllabus & credit remains the same as that of ECT3024 of MSc (ECT)
MEAC 3034: Microprocessor-II & Microcontrollers (100 marks) (L=04, P=01)
Syllabus & credit remains the same as that of ECT3034 of MSc (ECT)
MEAC 3046 : Introduction to Nanoscience and Nanotechnology (100 marks) (L=04,T=01,T=01)
Syllabus & credit remain the same as ECT3046(C) of MSc(ECT)
MEAC 3054 : Project Work/Dissertation (Phase-I) 100 Marks (T=01, P=03)
Course outcomes remains the same as that of ECT 3054 of MSc(ECT)

MEAC 3064 : Advanced Design Laboratory 100 Marks (P=03, T=01)
Syllabus and credit remains the same as that of paper ECT3064 of MSc(ECT)

FOURTH SEMESTER (ECT)

ECT4014: Electrical Machines (100 marks) (L=03, T=01, P=0)	
Course outcome: By the end of this course, students will be able to ▪ Explain Working, construction of DC & AC motors ▪ Analysis of DC & AC motor circuits ▪ Analysis of transformer used in electrical machines	
Unit-1	**D.C. Motors:** Basic principles, circuit / block diagram, working, Calculation of the back e.m.f. and torque produced in a dc motor, control of torque and speed using bridge rectifiers, variation of torque, pole flux, armature voltage and power with speed, idea of copper and iron losses. Applicationspoint number. Instruction set: - Zero, one two and three address instructions **(20 marks)**.
Unit-2	**Induction motors:** Basic principles, circuit / block diagram, working; Idea of the rotating magnetic field, equivalent circuit for and induction motor. Derivation of torque and its functional dependence on the slip and the line frequency, Starting and breakdown torque, operation of an induction motor for low slips, Speed control using converter and inverter circuits (Block diagram) **(25 marks)**.
Unit-3	Basic principles, circuit / block diagram, working; Types and quivalent circuits for **Single and multiphase phase motors (5 marks)**.
Unit-4	**Synchronous motors:** Basic principles, circuit / block diagram, working; Need for synchronous speed, Dependence of the torque on the angle between rotor and resultant magnetic field pull-cut torque, non starting nature, control of speed (block diagram). Merits and demerits of three types of motors. Stepper motor- Basic principles, circuit / block diagram, working; Types of stepper motor-

	detailed working of each of them;Applications**(25 marks)**.
Unit-5	**Transformer:** Basic principles, circuit / block diagram, working; Equivalent circuit diagrams; Types like- core type, shell type, single phase and multiphase- detailed working of each of them; Ideal transformer; Efficiency and Power factor calculation; Applications; Relay- Basic principles, Circuit / Block diagram, Working; Equivalent circuit diagram**(25 marks)**.

Suggested Reading

1. Electrical technology – B.L.Thareja, Kanna Publications
2. Fundamentals of Electrical technology- Del Toro, PHI

ECT4024 : Communication Networks (100 Marks) (L=03, T=01, P=0)

Course outcomes: By the end of this course, students will be able to

- Explain origin of internet and computer network
- Explain various topologies of computer network
- Analyze data communication protocol for TCP/IP network

Unit-1	**Introduction:** Computer Network: - Definition, necessity, basic types – LAN, MAN, WAN, Wireless networks, Inter networks; Network software: - Protocol definition, hierarchies, design issues, NETBIOS, interfaces and services; Connection-oriented and connectionless services. Reference Models: OSI Reference model, description of the seven layers TCP/ IP reference model, comparison of OSI & TCP/ IP reference models. Example Networks- Novell Network, ARPANET, Internet, Blue tooth- Pico net, SONET. Data Communication services – SMDS (Switched multi megabit data service), X.25 Networks, cellular service, mobile wireless, and frame relay, ISDN, ATM, Comparison of services **(5 marks)**.
Unit-2	**Physical Layer**: Band limited signals, Shannon's Channel capacity theorem. Transmission Media: - Wired – magnetic, twisted pair, Base band coaxial, Optical Fiber; Wireless- Short wave radio, microwave, infrared & millimeter wave; Satellite communication; GSM, Transmission Impairments. Data Encoding – Digital Data – Digital Signals; Digital Data – Analog Signals; Analog Data – Digital Signals, Analog Data – Analog Signals. Transmission Models – Serial Parallel, Synchronous – Asynchronous, Full Duplex, Interfacing. Multiplexing – FDM, TDM, Statistical TDM, WDM, WANs – Circuit, Packet & Message Switching. LANs-Architecture, Configurations**(20marks)**.
Unit-3	**Data link Layer:** Data Link Control – Flow Control; Error Detection, Correction & Control; Framing. Data Link Protocols – Unrestricted Simple Protocols, Simplex stop -and-wait Protocol, Simplex Protocol for a Noisy channel. Sliding Window Protocols – One bit Sliding window protocol, protocol using go back n, Protocol Using selective repeat, Petri Net Models.Example of Data Link Protocol – HDLC – High Level Data Link Control, Data Link Layer in the Internet, Data Link Layer in ATM**(10 marks)**.
Unit-4	**Medium Access Sub layer:** Channel Access Control – ALOHA, Carrier Sense Multiple Access Protocol, Collision Free Protocols, Limited Contention Protocols, WDMA Protocols, Wire Less LAN protocols, CDMA.IEEE Standard Protocols For LAN's & MAN's – 802.2 Logical Link Control, 802.3 CSMA/CD, 802.4 Token Bus, 802.5 Token Ring Protocols. Comparison between the above; 802.6 Distributed Queue Dual Bus.Bridges – Bridges from 802.x to 802.y; Transparent Bridges; Source routing bridges. High Speed LAN's – FDDI (Fiber Distributed Data Interface), Fast Ethernet, HIPPI (High Performance Parallel Interface), and Fiber channel. Satellite Networks – Polling, ALOHA, FDM, TDM, CDMA**(10 marks)**..
Unit-5	**Network Layer Services:** Virtual Circuits & Data grams;Routing Algorithm – Kruskal's, Dijkstra's, Bellman-Ford's & Prim's; Routing methods: Session Routing, Adaptive & Non adaptive Routing, Hierarchical Routing, Routing for mobile host, Broadcast of multicast

	routing;Congestion Control Algorithm-Principles, policies, traffic shaping; Leaky Bucket Algorithm, Token Bucket Algorithm; Congestion Control in virtual circuit subnet; Congestion Control for multicasting; Internetworking: Concatenated virtual circuit, connectionless internetworking, Tunneling; Firewalls;Network Layer in the Internet: IP Protocol, IP addresses, subnets, Internet Control Message Protocol, Address Resolution Protocol, Reverse Address Resolution Protocol; Internet Multicasting, Mobile IP, CIDR (Classless Inter-Domain Routing), IPv6**(10 marks)**.
Unit-6	**Telephone system:** Structure, PSTN topologies. Policies; Local loop; Trunk & Multiplexing; Switching; WLL (wire less in local loop);ISDN & ATM – Services, System architecture, Interface; Narrowband ISDN; Wide band ISDN;ATM networks; ATM switches**(15 marks)**.
Unit-7	**Transport Layer:** Services – Types, Quality, Primitives; Elements – Addressing, Establishment & release of connections, Flow Control & Buffering, Multiplexing, Crash Recovery; Protocols – Examples Service Primitives, Example Transport entity, TCP - Model, Protocol, Segment Header, Connection Management, Transmission Policy, Congestion Control, Timer Management, UDP, Wireless TCP & UDP, Protocols for Gigabit Networks**(10 marks)**.
Unit-8	**Application Layer:** Network Security – Traditional Cryptography, Cryptography principles, Secret Key & Public Key Algorithm, Authentication Protocols, Digital Signatures; DNS – Domain Name System – DNS Name Space, Resource records, Name Servers.; SNMP – Simple Network Management Protocol – SMNP Model, ASN.1, Structure of Management Information (SMI), Management Information Base (MIB), SNMP protocol. E – Mail – Architecture & Services, User Agent, Message Format, Message Transfer, Privacy. **(15 marks)**.
Unit-9	**World Wide Web:** Architecture; Browsing; Client side; Server side; Locating information on the web; URL**(5 marks)**.

Suggested Reading:

1. Computer networks – Tanenbaum, Pearson Education
2. Data & Computer Communications – Stallings, Pearson Education
3. Digital & Data Communication –Miller, Jaico
4. Communication System –Simon Haykin, John Wiley
5. Digital Communication -Proakis, Mc Graw Hill, 4th Edition
6. Communication Engineering –Proakis, 2nd Edition, Pearson
7. Data Communication –Prakash C – Gupta, PHI.
8. Data Communication-Halsall, Pearson Education
9. Understanding Data Communication-Held, Pearson Education
10. Computer Networking-Kurose, Pearson Education
11. Introduction to Computer Networking-Mansfield, Pearson Education
12. Computer Networking with Internet Protocols-Stallings, Pearson Education

ECT4034: Photonics (100 marks) (L=03, T=01, P=0)

Course outcomes: By the end of this course, students will be able to

- Explain the importance of photonics
- Explain working principle of lasers and optical modulators
- Modeling and design of photonic devices

(The course instructor should introduce use of OptiWave/COMSOL packages as part of this course)

Unit-1	**Introduction:** Importance of Photonics in Electronics and communication; review of electromagnetic theory of light, ray optics, wave optics, beam optics, Physics of thin film optical devices – anti-reflection coating, beam splitter, reflection enhancer, spectral filters, CD-ROMS etc**(10 marks)**.
Unit-2	**Quantum Electronics and statistical optics:** Photons and atoms – spontaneous emission, absorption, stimulated emission, Einstein co-efficient, theory of laser oscillation, pumping schemes, rate equations, characteristics of laser output, line shape functions, line broadening, laser

	mode selection; laser cooling and trapping of atoms, hole burning; Case studies of He-Ne, Ar, CO2, Ruby, Nd-Yag, X-ray lasers; Pulsed laser - Q-switching, mode locked laser, ultrafast laser. Case studies on industrial and scientific applications of laser. Statistical optics – statistical properties of random light waves, partially coherent light waves and partial polarization**(20 marks)**
Unit-3	**Fourier optics and Holography:** Review of Fourier transform, two-dimensional Fourier transform and convolutions in optics . Fraunhofer diffraction, Fourier transform properties of lens. Types of holograms, physics of information recording and reconstruction with hologram; Application of holography in microscopy, interferometery, character recognition; quantitative theory of spatial frequency filtering and its applications**(20 marks)**
Unit-4	**Electro-optic, acousto-optic and magneto-optic effects:** Review of polarization and crystal optics; Principles of electro-optics – Pockel and Kerr effects, scanner, directional coupler, spatial light modulators; electro-optics of anisotropic materials, liquid crystals, photorefractive materials. Interaction of light with sound –Bragg diffraction of beam, coupled wave theory; Acousto-optic modulator, scanner, filter, frequency shifter and isolator; acousto-optics of anisotropic media. Basic idea of magneto-optic effect. Photonic switching and computing: Photonic switch based on Electro-optic, Acousto-optic effect and magneto-optic effects; all optical switch, bistable switch, optical interconnects and computing **(20 marks)**.
Unit-5	**Non-linear optics & Nanophotonics:** Non-linear optical media, second, third order non-linear optical effects – wave mixing and conjugation; coupled wave theory, anisotropic and dispersive non-linear media; optical solitons. Nanoparticles, Quantum dots, quantum wells; lasers and LED based on quantum dot and Quantum wells; Photonic crystals (PhC) – basic principles, PhC beam splitter, power combiner, resonator; photonic crystal based fibers as waveguide; Negative refractive index materials, Surface Plasmon Resonance, basic components and devices of Integrated optics **(20 marks)**.
Unit-6	**Biophotonics:** Photobiology, Light – matter interaction, photobiology; biosensors, bioimaging techniques – fluorescence microscopy, confocal microscopy, optical tomography, single photon and multiphoton microscopy; terahertz spectroscopy and imaging **(10 marks)**.

Suggested Reading

1. Fundamentals of photonics – B.E.A. Saleh, M.C.Teich, Wiley Interscience
2. Principles of Nanophotonics – E.R. Pike, R.G.W. Brown, Taylor and Francis
3. Photonic crystal – J.D.Joannopolous et. al, Princeton Univ. Press.
4. Integrated Optics – K. Iga, Y. Kokobun, Taylor and Francis

ECT4046(A) : Web Technology (Elective) (100 marks) (L=04, T=01, P=01)

Course outcome: By the end of this course, students will be able to

- Explain origin of internet and WWW
- Design static and dynamic web page
- Illustrate proficiency in web page scripting skills

(The course instructor should introduce use of HTML5, AJAX, JavaScript on designing .NET & Java based web application)

Unit-1	**Introduction to Computer Networks:** Fundamentals of Computer Networks and the Internet, application layer protocols, transport layer protocols, network layer and routing, link layer and local area networks, security in computer networks. Introduction to World Wide Web (WWW), development of WWW, Graphical user Interface**(20 marks)**
Unit-2	**Weaving the web:** Introduction to Hyper Text Markup Language (HTML), Extensible Hypertext Markup Language (XHTML), and Extensible Markup Language (XML) to create web pages, Moving from HTML to XHTML, XHTML element structure, style sheets, using JavaScript to display to XML, introduction to XML DOCTYPES and their uses, XML in web publishing environment**(20 marks)**

Unit-3	**Imaging Technologies for Web Publishing:** Image file formats, creating low bandwidth graphics, using color, browser-safe colors, imaging transparency, creating graphical navigation tools, scanning techniques, creating small animations, image mapping, using scalable vector graphics (SVG), and graphical layout and alignment. Fundamentals of creating dynamic, interactive web pages: An introduction to Active Server Pages (ASP) technology, ASP syntax, and introduction to VBScript, the request, response, server, application, and session objects, working component, and connecting databases to ASP pages. **(20 marks)**
Unit-4	**Java in Web Publishing:** Preparing Java applets using the Abstract Windows Toolkit (AWT) framework, basic graphics features provided by Java Language**(20 marks)**
Unit-5	**Web Services (WS):** Different implementation Techniques of WS, Dot-Net –Based WS Initiatives, Java-Based WS Initiative J2EE, Comparison of Dot- Net base and XML bas WS initiatives. The performance, efficiency, scalability, power, time-to-Market features, the portability etc., support of both the techniques for existing systems, The migration from previous platform of both the techniques**(20 marks)**

Suggested Reading:

1. Web Design, The complete reference, Second Edition- Thomas A. Powel, Tata McGraw Hill.
2. The HTML 4.0 Source book- Ian Graham, John Wiley
3. The XML Specification Guide- Ian Graham and Liam Quin, John Wiley
4. The XHTML 1.0 Web Development Sourcebook- John Wiley and Sons.
5. Web Services Security- Mark O'Neill, et al. Tata McGraw Hill.

ECT4046(B) : Digital Signal Processing (Elective) (100 marks) (L=04, T=01, P=01)

Course outcome: By the end of this course, students will be able to

- Explain advantages of digital signal processing
- Solve Digital signal processing problems
- Applications of DSP algorithms

(MATLAB bases assignments related to topics covered in the course. A minimum of ten such experiments should be conducted)

Unit-1	**Review of Signals and Systems**- definition and types; sampling, quantization, ADC and DAC; IIR and FIR systems; Fourier transform, DTFT, DFT and Properties; FFT-decimation in time and frequency, z-transform **(20 marks)**
Unit-2	**Information Theory:** Definition- Uncertainty, Information and Entropy; Source coding, Mutual Information, Channel Capacity and Channel Coding Theory; Information Capacity Theorem; Rate Distortion Theory **(10 marks)**
Unit-3	**Effects of finite word length in digital systems:** Introduction; Representation of numbers- fixed point, floating point; Rounding and Truncation Errors; Quantization Effects in ADC and DAC processes; Noise power from a digital system; Coefficient quantization effects in direct form realization of IIR and FIR systems **(10 marks)**
Unit-4	**Implementation of discrete systems:** Structures for FIR systems- direct form, cascade form, frequency sampling and lattice structures; Structures for IIR systems- Direct form, Signal flow graphs and transpose forms, cascade forms, parallel forms, lattice and lattice-ladder structures; Round off effects in Digital filter structures**(20 marks)**

Unit-5	**Design of Digital Filters**: Representation of 1 st & 2 nd order recursive & non-recursive filters; Digital-filter realizations from analog forms using impulse invariance, bilinear transforms; Low-pass, High- pass Filters FIR Filter, Low pass, High pass IIR filters, Comb filters; Filter design by windowing method. Design of FIR- symmetric and anti-symmetric FIR filters, Linear pahse filters using windows and frequency sampling; FIR differentiators; Least square method- Pade approximation, FIR Least Squares Inverse (Wiener) Filter. **(20 marks)**
Unit-6	**Prediction:** Innovations representation of a random process; Forward and Backward Prediction; Solution to normal equations- Levinson-Durbin Algorithm, Schur Algorithm; Properties of Linear Prediction Filters; AR and ARMA Lattice-Ladder structure; Wiener filters for prediction. **(20 marks)**

Suggested Reading

1. Digital Signal Processing- Proakis, Pearson Education
2. Digital Signal Processing- Mitra, TMGH
3. Digital Signal Processing- Salivahanan, Vallavraj, Gnanapriay, TMGH

ECT4046(C) : Introduction to Nanoelectronics (Elective) (100 marks) (L=04, T=01, P=01)

Course outcomes: By the end of this course, students will be able to

- Explain physics of nanoelectronic devices and their operation & applications
- Model nanostructure for electronic applications

(The course instructor should introduce suitable simulation/modeling tool as part of this course)

Unit-1	**Moore's law:** Transition from microelectronics to nanoelectronics, Importance of nanoelectronics
Unit-2	**Nanostructure devices:** resonant tunneling diode (RTD), its structure and derivation of I-V characteristics, RTD as microwave oscillator, Single electron transistor (SET), coulomb diamond structure, application of SET, nanowire FETs, CNT transistor & its RF circuit model**(20 marks)**
Unit-3	Quantum dots (QDs) as nanoelectronic circuit components, Quantum Dots as electronic filter, circuit elements at optical frequencies: nanoinductor, nanocapacitor & nanoresistor, core/shell nanocomposites as nano-optical antenna, nano-optical Yagi-Uda antenna; Nanostructures as the fourth basic passive circuit element "memristor" – its theory and application **(20 marks)**.
Unit-4	**Properties of nanostructures:** Photocatalysis, Dielectric properties, Magnetic properties, optical properties, Mechanical properties, Electrical properties, Surface effects and physical properties of nanoparticles **(10 marks)**
Unit-5	**Nanophotonic devices:** Introduction to solar cells, different types of solar cells: thin film solar cell, Dye – sensitized solar cell, Quantum dot solar cell, Quantum Dot dye sensitized solar cell, Effect of electrolyte, energy band diagram of quantum dot solar cell, efficiency, Quantum Dot LED (QDLED), Quantum dot photodetectors, Quantum Dot laser **(20 marks)**
Unit-6	Carbon nanotube memory devices, CNT based resonator, Nanomotors, Graphene based devices, Nanomedecine, Nanotechnology & environment **(15 marks)**
Unit-7	**Modeling and Simulation of Nanodevices:** Importance of measurement and estimation of electrical and optical properties of nanoparticles for device modeling,Modeling and Simulation of Quantum Dots and Core-Shell nanoparticles for application as nano – optical antenna, Design of nano-optical Yagi-Uda antenna and study of its characteristics; Modeling of nano MOSFET and nano MOS capacitor. Modeling of Coloumb Blockade effect for Quantum Dots; modeling and simulation of different properties of Carbon nanotube **(15 marks)**

Suggested Reading

1. Fundamentals of Nanoelectronics – Gworge.W. Hanson, Pearson
2. Introduction to Nanoelectronics – Mitin, Kochelap and Stroscio, Cambridge Univ. Press

ECT 4056 : Project Work/Dissertation (Phase-II) 100 Marks (L=00, T=02, P=04)
Course outcomes: By the end of this course, students will be able to ▪ Carry out literature review ▪ Generate Problem definition ▪ Carry out a detail study and solution of a chosen research problem ▪ Demonstrate skills for writing reports, papers & articles.

FOURTH SEMESTER (MEAC)

MEAC4014: Digital system design with VHDL (100 marks) (L=03, T=0, P=01)	
Course Outcomes: By the end of this course, students will be able to ▪ Explain VHDL syntax and programming techniques ▪ Modeling and simulation of digital logic circuits with VHDL ▪ Implement digital logic circuits on FPGA boards **(Laboratory sessions on VHDL programming & circuit implementation has to be done as part of the course)**	
Unit-1	**Introduction:** EDA tools and hardware description languages (HDL) – System C, Verilog and VHDL. Concurrency in HDL , hardware synthesis and design flow; translation of HDL codes into digital circuits**(5 marks)**
Unit-2	**Basics of programmable logic devices:** FPGA and CPLD)- their architectures; clock distribution schemes, grounding, power supply, I/O lines; concept of IP cores, soft-core processor **(5 marks)**.
Unit-3	**Introduction to VHDL:** Advantages of using VHDL as hardware description language; VHDL Code structure –library, declaration, entity, architecture; VHDL data types & operators -Predefined types, user defined types, subtypes, arrays, signed and unsigned data types, data type conversion**(10 marks)**.
Unit-4	**VHDL Operators:** Logical, arithmetic, comparison, shifting, concatenation; attributes, user defined attributes, operator overloading. VHDL Signals & variables: constant, signal, variables**(15 marks)**
Unit-5	**Concurrent statements:** Structure of when, generate, block statements; Sequential statements – structure of process, if, wait, case, loop statements**(15 marks)**
Unit-6	**Writing VHDL codes & Test bench:** Combinational and sequential circuits – logic gates, arithmetic circuits, multiplexer, flip flops, counters, shift registers, sequence generator; Barrel shifter, signed and unsigned comparator, serial data receiver, parallel to serial / serial to parallel converter, Digital filter design with VHDL**(40 marks)**
Unit-7	**Elements of system design:** State machines, Package, components, port map, Functions and procedure; Partitioning, place & route and implementation, bit file generation and FPGA programming & testing**(10 marks)**.
Suggested Reading 1. VHDL Programming by examples – Douglas Perry, 4th Edition, McGraw Hill 2. Circuit Design with VHDL – V. A. Pedroni, PHI	

3. VHDL for programmable logic – K. Skahill, Pearson
4. Xilinx ISE / ModelSim IDE tutorials on VHDL programming

MEAC4024: Communication Networks (100 marks) (L=03, T=01, P=0)

Syllabus remains the same as ECT4024 of MSc(ECT)

MEAC4034: Introduction to Nanoelectronics (100 marks) (L=03, T=00, P=01)

Syllabus remains the same as ECT4046(C) of MSc(ECT)

MEAC 4046(A): Web Programming (Elective) (100 marks) (L=04, T=01, P=01)

Syllabus remains the same as ECT4046(A) of MSc(ECT)

MEAC4046(B): Satellite Communication (Elective) (100 marks) (L=04, T=01, P=01)

Course outcomes: By the end of this course, students will be able to

- Explain the benefit of satellite communication
- Explain satellite communication systems and processes

(Theory class should be supported by Laboratory session depending on available facility)

Unit-1	**Satellite orbits:** Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion. **(20 marks)**
Unit-2	**Space segment and satellite link design:** Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command. Satellite uplink and downlink Analysis and Design, link budget, E/N calculation- performance impairments-system noise, inter modulation and interference, Propagation Characteristics and Frequency considerations- System reliability and design lifetime. **(20 marks)**
Unit-3	**Satellite access:** Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Brocast, multiple access: FDMA, TDMA, CDMA, Assignment Methods,Spread Spectrum communication, compression – encryption. **(20 marks)**
Unit-4	**Earth segment:** Earth Station Technology-- Terrestrial Interface, Transmitter and Receiver, Antenna Systems TVRO, MATV, CATV, Test Equipment Measurements on G/T, C/No, EIRP, Antenna Gain. **(20 marks)**
Unit-5	**Satellite applications:** INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- direct to home Broadcast (DTH), Digital audio broadcast (DAB)- Worldspace services, Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet**(20 marks)**

Suggested Reading:

1. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.
2. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, 'Satellite Communication Systems Engineering', Prentice Hall/Pearson, 2007.
3. N.Agarwal, 'Design of Geosynchronous Space Craft, Prentice Hall, 1986.
4. Bruce R. Elbert, 'The Satellite Communication Applications' Hand Book, Artech House Bostan London, 1997.

MEAC4046(C): Mobile Communication (Elective) (100 marks) (L=04, T=01, P=01)

Course outcomes: By the end of this course, students will be able to

- Develop Cellular Concept and System Design Fundamentals
- Design of different Modulation and Signal Processing system for mobile communication
- Implement Wireless networking, design issues in personal wireless systems

(Theory class should be supported by Laboratory session depending on available facility)

Unit-1	**Introduction:** History and evolution of mobile radio systems; Types of mobile wireless services / systemsCellular, WLL, Paging, Satellite systems, Standards, Future trends in personal wireless systems **(5 marks)**
Unit-2	**Cellular Concept and System Design Fundamentals:** Cellular concept and frequency reuse, Multiple Access Schemes, channel assignment and handoff, Interference and system capacity, Trunking and Erlang capacity calculations; cellular concept, spectral efficiency; design parameters at base station: antenna configurations, noise, power and field strength; design parameters at mobile unit: directional antennas and diversity schemes: frequency dependency; noise; antenna connections; field component diversity antennas; signaling and channel access: word-error-rate, channel assignment **(25 marks)**
Unit-3	**Mobile Radio Propagation:** Radio wave propagation issues in personal wireless systems, , Representation of a mobile radio signal; Propagation models, propagation path loss and fading-causes, types of fading and classification of channels; prediction of propagation loss: measurements, prediction over flat terrain, point-to-point prediction, microcell prediction model; calculation of fades- amplitude fades, random PM and random FM, selective fading, diversity schemes, combining techniques, bit error-rate and word-error-rate; Multipath fading and Base band impulse respond models, parameters of mobile multipath channels, Antenna systems in mobile radio **(25 marks)**
Unit-4	**Modulation and Signal Processing:** Analog and digital modulation techniques, Performance of various modulation techniques-Spectral efficiency, mobile radio interference: co-channel and adjacent-channel interference, intermodulation, intersymbol and simulcast interference; frequency plans: channelized schemes and frequency reuse, FDM, TDM, spread spectrum and frequency hopping, Error-rate, Power Amplification, Equalizing Rake receiver concepts, Diversity and space-time processing, Speech coding and channel coding **(25 marks)**
Unit-5	**System Examples and Design Issues:** Multiple Access Techniques- frequency division multiple access, time division multiple access, code division multiple access, space division multiple access, operational systems, Wireless networking, design issues in personal wireless systems; Cellular CDMA: narrow band and wide band signal propagation, spread spectrum techniques, capacities of multiple access schemes; micro cell systems: conventional cellular system, micro cell system design, capacity analysis **(20 marks)**

Suggested Reading:

1. Wireless digital communications- K.Feher, PHI,
2. Wireless Digital Communications Principles and Practice - T.S.Rappaport, Pearson Education
3. Mobile communications Engineering: Theory And Applications- W.C.Y.Lee McGraw Hill,
4. Mobile Communications- Schiller, Pearson Education
5. Wireless Communications and Networks -Stallings, Pearson Education
6. Wireless Communication Systems -Wang and Poor, Pearson Education

MEAC4046(D): Fiber Optic Communication (Elective) (100 marks) (L=04, T=04, P=01)

Course outcomes: By the end of this course, students will be able to

- Origin of light wave communication
- Explain elements of fiber optic communication system
- Design of communication system

(Theory class should be supported by Laboratory session depending on available facility)

Unit-1	**Introduction:** Origin of optical communication, need for fiber optic communication systems, basic building blocks of fiber optic communication systems, present perspectives & future trends
Unit-2	**Optical Fibers:** Review of Maxwell's equation and propagation of EM waves dielectric waveguides, boundary conditions for total internal reflection of light in optical fibers, linearly polarized modes, guided, radiation and leaky modes, phase and group velocities, Gaussian beam and mode field distribution of light inside different types of optical fiber, power confinement, cut-off wavelength in single mode and multimode fibers; Optical attenuation & losses, dispersion and bandwidth, non-linear effects in single mode fibers **(20 marks)**
Unit-3	**Optical transmitter:** Characteristics of light emitting diodes and lasers for optical communication – quantum efficiency, modulation bandwidth, threshold current levels, spectral width, radiation patterns, and thermal effects; reading device data sheets of diode and lasers; modulation techniques of light for analog and digital signal transmission via fiber optic channels, digital data transmission format and encoding schemes; light coupling to optical fibers, typical circuits of optical transmitter module **(20 marks)**.
Unit-4	**Optical receiver:** Characteristics of different types of photo-detectors used in optical communication systems – power relationship, quantum efficiency, sensitivity and quantum limits, noise and noise equivalent power; equivalent circuit of photodiodes and bandwidth; analog signal and digital data recovery techniques, typical circuits of optical receiver datasheets for optoelectronic ICs used for signal reception purposes **(20 marks)**.
Unit-5	**Components of fiber optic networks:** Operation and characteristics of **s**emiconductor optical amplifiers, doped fiber amplifiers, couplers, splitters, isolators, circulators, attenuators, filters, optical switches, wavelength converters for wavelength division multiplexed (WDM) networks **(20 marks)**.
Unit-6	**Fiber Optic Networks:** Introduction to application of fiber optics in voice, video and data networks; WDM, DWDM, OTDM networks; Fiber optic cabling, splicing, connectors, receptacles, design, testing & troubleshooting of long haul fiber optic link, LAN, WAN; architecture of OSI reference model, SONET, ATM; network management, protection and restoration **(20 marks)**.

Suggested Reading:

1. Optical Fiber Communication - G. Keiser, McGraw Hill
2. Optical Fiber Communication – John M. Senior
3. Fiber optic communication Technology – M.Scheiner, Pearson
4. Integrated Optics – K. Iga, Y. Kokobun, Taylor and Francis
5. Fundamentals of photonics – B.E.A. Saleh, M.C.Teich, Wiley Interscience
6. Introduction to Opto- Electronics - J.Wilson and JFB Wilson, PHI
7. Optical Networks: A Practical Perspective - R. Ramaswami, K. Sivarajan, & G. Sasaki , M.Kaufmann

MEAC4046(E): Biomedical Instrumentation (100 marks) (IAP4046A)
(Under CBCS with Department Instrumentation & USIC) (L=4, T=01, P=01)

Course outcomes: By the end of this course, students will be able to

- Explain working of biomedical instruments
- Develop knowledge on different biomedical instrumentation system
- Design of measurement and analysis of complex biomedical systems

Unit I: Bio electric signals and Electrodes: Fundamentals of medical instrumentation- physiological system of the body sources of biomedical signals- basic medical instrumentation- intelligent medical instrumentation system- Origin of Bioelectric signals- Recording Electrodes–Silver – Silver chloride electrodes-Electrodes for ECG-Electrodes for EEG Electrodes for EMG Electrical conductivity of Electrode Jellies and Creams-Micro electrodes. **(20 marks)**

Unit II: Recording systems and recorders: Basic recording system-General considerations for signal conditioners preamplifiers-source of noise in low level measurements- Biomedical signal analysis technique-main amplifier and driver stage-writing systems- direct writing recorders-the ink jet recorders-potentiometric recorder-digital recorders-Instrumentation, tape recorders-Electrocardiograph, Vector cardiograph, Phonocardiograph– Electroencephalograph - Electromyograph and otherBiomedical recorders- Bio feedback instrumentation. **(20 marks)**

Unit III: Measurement and analysis techniques: The Heart and cardiovascular system - Heart Blood pressure - Characteristics of Blood flow – Heart Sounds (the cardiovascular system) -Electro cardiographymeasurement of Blood pressure-measurement of Blood flow and cardiac output, Plenthysmography - measurement of heat sounds-The physiology of the respiratory system of tests and instrumentation for the mechanics- breathing-Respiratory therapy Equipment- Origin of EEG-Action Potentials of the brain evoked potentials-Anatomy of the brain- brain waves- placement of electrodes-Recording set up- Analysis of EEG. **(20 marks)**

Unit IV: Magnetic Resonance and Ultrasonic Imaging systems: Principles of NMR Imaging system - Image reconstruction Techniques-Basic NMR components-Biological efforts of NMR Imaging- Advantages of NMR Imaging System -Diagnostic ultra sound-physics of ultrasonic waves-medical ultra sound- basic pulse – echo apparatus, A – scan -echocardiograph (M mode)- B-scanner-Real time ultrasonic Imaging systems-Multi element Linear , Array Scanners- Digital Scan converter-Biological effects of Ultra sound. **(20 marks)**

Unit V: Advanced Bio medical systems: Pacemakers- Need for Cardiac pacemaker- External Pace makers-Implantable Pace makers- recent developments in Implantable Pacemakers-Pacing system Analyzer-Defibrillators- Need for a Defibrillator- DC Defibrillator- Implantable Defibrillators-Pacer - Cardioverter – Defibrillator Analyzers - Physio therapy and electro therapy equipment- High frequency heat therapy – short wave diathermy– microwave and ultrasonic therapy – pain relief through electrical simulation**(15 marks)**

Unit VI: Biotelemetry: Transmission and reception aspects of biological signals via long distances, Aspect of patient Care monitoring. **(05 marks)**

Suggested Readings

1. J S Webster, Medical Instrumentation-Application and Design.
2. L Cromwell, Biomedical instrumentation. PHL
3. R S Khandpur, Handbook of Biomedical Instrumentation, TMHN. Delhi, 1991.

4. B R Astor–Introduction to Biomedical Instrumentation and Measurement, MacMillan.

MEAC 4056 : Project Work/Dissertation (Phase-II) 100 Marks (L=0, T=02, P=04)

Same as that of **ECT4056 of** MSc(ECT)

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