# Vidyasagar University

Post Graduate Syllabus

in

Electronics

under Choice Based Credit System

(CBCS)

[ w.e.f. : 2016-2017 ]

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## Semester-1

| | | Topic | Marks | Credit |
|---|---|---|---|---|
| Theory Papers | ELC-101 | Mathematical Methods | 50 | 4 |
| | ELC-102 | Network Analysis and Synthesis | 50 | 4 |
| | ELC-103 | Electronic Materials | 50 | 4 |
| | ELC-104 | Analog Electronics | 50 | 4 |
| Practical Papers | ELC-105 | Computational & Programming Lab | 50 | 4 |
| | ELC-106 | Analog Circuit and Design Lab | 50 | 4 |

## Semester-2

| | | Topic | Marks | Credit |
|---|---|---|---|---|
| Theory Papers | ELC-201 | Signals and Systems | 50 | 4 |
| | ELC-202 | Semiconductor Device | 50 | 4 |
| | ELC-203 | Digital Electronics and Mobile Communication. | 50 | 4 |
| | ELC-204 | Elective-1 (Introduction to Electronics and Electronic waste management) | 50 | 4 |
| Practical Papers | ELC-205 | Digital Electronics Lab | 50 | 4 |
| | ELC-206 | Semiconductor Device Lab | 50 | 4 |

## Semester-3

| | | Topic | Marks | Credit |
|---|---|---|---|---|
| Theory Papers | ELC-301 | Advanced Electromagnetic Theory and Radiating systems. | 50 | 4 |
| | ELC-302 | Communication Systems | 50 | 4 |
| | ELC-303 | VLSI Engineering | 50 | 4 |
| | ELC-304 | Elective-2(History of Electromagnetic and Communication) | 50 | 4 |
| Practical Papers | ELC-305 | VLSI lab | 50 | 4 |
| | ELC-306 | Communication Lab | 50 | 4 |

## Semester-4

| | | Topic | Marks | Credit |
|---|---|---|---|---|
| Theory Papers | ELC-401 | Microwave and Power Electronics | 50 | 4 |
| | ELC-402 | Microprocessor and its Applications | 50 | 4 |
| | ELC-403 | Control Systems and Instrumentations | 50 | 4 |
| | ELC-404 | Optical Communication and Information Processing | 50 | 4 |
| Practical Papers | ELC-405 | Microprocessor Lab | 50 | 4 |
| | ELC-406 | Project Work | 50 | 4 |

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# Semester – I

**Paper-ELC 101 (Theory)**
**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Mathematical Methods

1. Vector spaces and matrices: Vector spaces of n dimensions, inner product, Schmidt's orthogonalisation, Schwarz and Bessel inequality.
2. Hermitian and unitary matrices, eigenvectors and eigenvalues, diagonalization, unitary transformation. Cayley Hamilton theorem.
3. Integral transforms: Laplace transform: Properties of Laplace transform, Inversion formula, Convolution, Application to ordinary and partial differential equations; Fourier transform: Properties of Fourier transform, Inversion formula, Convolution, Parseval's relation, Application to ordinary and partial differential equations.
4. Special Functions: Legendre Equation: Generating function, Legendre functions of the first kind and second kind, orthogonal properties, Rodrigue's formula, Bessel Equation: Bessel function, Series solution of Bessel equation, Recurrence relations.
5. Complex variables: Function of a complex variable, Limit, Continuity, Differentiability, the definition of an analytic function, Cauchy-Riemann equation, construction of analytic function, complex integration, Jordan arc, Cauchy's theorem, Cauchy's integral formula, More's theorem, Liouville's theorem, Taylor's and Laurent's series.

## Numerical Analysis

1. Numerical arithmetic: Representation of integers, real numbers, floating point representation, floating point operators, IEEE standards of floating point numbers, Absolute and relative error, Error propagation, stability and ill conditioning, Order of approximation, Truncation error.
2. Numerical differentiation: Derivatives from divided difference table, central difference formula.
3. Numerical integration: Trapezoidal rule, Newton-Cotes formula.
4. Interpolation and extrapolation: Lagrange's, spline and rational function, interpolation and extrapolation.
5. Solving of polynomial equation: Gauss and Gauss-Jordan methods, III conditioned systems.
6. Ordinary differential equation: Runge-Kutta method, Adams-Moulton, Adams-Bash forth method.

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**Probability and Statistics**

Mean, median, mode and standard deviation; combinatorial probability, probability distribution functions - binomial, Poisson, exponential and normal; Joint and conditional probability; Correlation and regression analysis.

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## Paper-ELC 102 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

### Network Analysis and Synthesis

1. Network Theorem: Review of network theorems (Thevenin, Norton, superposition, Maximum power transfer, Reciprocity theorem in case of AC and DC application both) Network Graphs, Matrices associated with graphs, incidence, Fundamental tie set and cut-set matrices. Node and mesh analysis.
2. Analysis: Equivalent circuits, two-port parameters, hybrid parameters, Z,Y, and ABCD parameters. Topological description of different commonly used networks, Π to T and T to Π conversions, reduction of complicated network. Image impedance of a network, symmetrical network, characteristic impedance and propagation constant of a network.
3. Time response of linear L, C, R circuits and combinations. Frequency domain networks, Transformation of R, L, C mutual inductances and combination networks in frequency domain. Phasor diagram, driving port impedance and transfer impedances.
4. Filter circuits: L filter, Π filter, Methods of development of different filters like high pass, low pass, band pass and band stop filter circuits.
5. Network analyzing using Laplace Transform, concept of Impedance Function and its application, partial fraction expansion, Poles and Zeros, Time-domain behaviour from pole-zero plot, Convolution integral, concept of Transfer functions.
6. Network Synthesis, Definition of Positive Real Functions, Testing procedure for P.R. functions, Derivation of Synthesis technique for one port passive network (Foster and Cauer form), Synthesis of two-port networks by ladder technique.

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## Paper-ELC 103 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

### Electronic Material

1. Introduction: Material Science and Engineering, Classification of engineering materials, levels of structure, Structure property relation in materials.
2. Lattice defects: classification of imperfection, point defect, line defects, planar defects, color centers: F and V centers.
3. Electrical properties of metals: Conductivity, reflection and absorption, Fermi surfaces, thermo electric phenomena. Conduction in metals oxides, amorphous materials. classical free electron theory of metals, Drawbacks of classical theory, relaxation time, collision time and mean free path, electrical conductivity from quantum mechanical consideration, electron scattering and resistivity of metals, qualitative discussion on the feature of the resistivity, electrical conductivity at low temperature, Boltzman transport equation, Hall effects in metal, selection of electrical engineering materials
4. Dielectric Properties of materials: Macroscopic electric field, polarization, Types of polarization, internal fields in solid and liquid, dielectric constant of solid and polarizability, Behavior of dielectrics in alternating fields, ferroelectricity, anti ferroelectricity, phase transition, piezoelectricity.
5. Optical properties of materials: Optical constants and their physical significance, Kramers – Kronig Relations, Electronic inter bond and intra bond transitions Relations between optical properties and band structure – colour of material (Frenkel Excitons), Bond Structure determination from optical spectra reflection, refraction, diffraction, scattering, dispersion, photoluminescence, Electroluminescence.
6. Magnetic Properties of Materials: Dimagnetism, paramagnetism, various contributions to para and diamagnetism, Adia-batic demagnetization, Paramagnetic susceptibility. Ferromagnetism, ferrimagnetisms, structure of ferrites ,Ferrites spin wave, curic point, temperature dependence of saturation magnetization, saturation magnetization at absolute zero, magnons and their thermal excitation, dispersion relation,
7. Superconducting materials: Superconducting states, Meissner effect Fluxoid, Penetration depth, Type-1 and Type-II semiconductors, BCS theory, Josephson Superconducting tunneling: DC and AC Jopshen effect, High $T_c$ superconducting material.

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## Paper-ELC 104(Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

### Analog Electronics

1. Diode: ideal diode, thermal characteristic of junction diode, piecewise liner model, diode logic gates, clipper, clamper, voltage doublers.
2. Bipolar Junction Transistor: BJT as an amplifier and switch, transfer characteristic, small signal operation and modelling, internal capacitances, high frequency model of BJT, CB,CE,CC mode of operation .
3. MOSFET: MOSFET operation, Small signal and large signal model, MOS switch, MOS amplifier, MOS biasing, CS, CD, and CG using MOSFET.
4. Transistor Amplifiers: RC coupled amplifier, functions of all components, equivalent circuit, derivation of voltage gain, current gain, input impedance and output impedance, frequency response characteristics, lower and upper half frequencies, bandwidth, and concept of wide band amplifier.
5. Feedback Amplifiers: Emitter follower, Darlington amplifier, Bootstrapped Darlington amplifier.
6. Operational Amplifier: Internal architecture OP-Amp, OP-Amp as Comparator, Schmitt triggers, Instrumentation Amplifiers, Logarithmic Amplifiers, Anti-log amplifiers, Multipliers, Divider., Active filters, 1st, 2nd and higher order low pass and high pass active filters, Butterworth, Chebychev and Bessel response, band-pass and band-stop active filters.
7. Voltage Regulator: Regulated power supply, series regulation using OP-Amp, Monolithic voltage regulator, details of standard power supply unit, switch mode power supply (SMPS).
8. Signal Generator: Crystal oscillator, tuned oscillator, voltage controlled oscillator (VCO), pulse generator, ramp generator, square and triangular wave generator.
9. Phase Locked Loop (PLL) & Applications: PLL operating principles, monolithic PLLs. Applications of PLL - Frequency multiplication, tracking, FM demodulation.

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**Paper: ELC - 105**

**Full Marks: 50**
**Credit: 4**

## Computation & programming laboratory

**Apart from executing the programs prescribed in the syllabus, students should be encouraged to execute other problems associated with C Programming Language with similar complexity. Problems other than those listed below may also be set in final examination of similar complexity and conformity to the theory syllabus.**

**Write programs using C Programming Language to perform the following tasks:**

**List of Assignments:**

1. Find factorial of an integer N where N may be read from the keyboard. Write the program (a) without using recursion and (b) using recursion.

2. Check a number N enter through keyboard is prime or non-prime.

3. Calculate the first N Fibonacci numbers where N may be read from the keyboard.

4. Check a number N enter through keyboard is Armstrong or not.

5. Convert decimal to binary and vies-versa.

6. Obtain the sum of the first N terms of (a) an A.P. series and (b) a G. P. series. Read the required variables from the keyboard.

7. Calculate the functions sin(x), cos(x) and exp(x) by representing each of them as an infinite series. Read in the value of the desired accuracy from the keyboard. Also find the numbers of terms calculated to achieve desire accuracy.

8. Sort an array of numbers in (a) ascending and (b) descending order using the Bubble sort algorithm.

9. (a) Given two m x n A and B matrices, calculate A + B and A – B. Read the individual elements from the keyboard.
   (b) Given an m x k matrix A and a k x n matrix B, evaluate A*B.

10. Solve a given polynomial equation numerically using (a) Newtow-Raphson method (b) Bisection method. Read in the polynomial coefficients and accuracy from the keyboard.

11. Given a polynomial function f(x). Calculate using (a) Simpson's 1/3 rule (b) Trapezoidal rule the $\int f(x)dx$ within specified limits. Compare the answer with that obtained analytically.

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**Paper: ELC – 106**
**Full Marks: 50**
**Credit: 4**

## Analog Circuit and Design laboratory

1. Fixed bias circuit of a BJT amplifier
   Design a fixed bias transistorized amplifier and measure $V_{BE}$, $V_{CE}$, $V_{CB}$, $I_C$, $I_B$, $I_E$ at Q point. Repeat the same with different BJT.

2. Study of self biased transistorized amplifier.
   Design a self bias transistorized amplifier and measure $V_{BE}$, VCE, VCB, $I_C$, $I_B$, $I_E$ at Q point. Repeat the same with different BJT.

3. Frequency response of voltage divider bias circuit of BJT using $R_E$ unbypassed.
   Study frequency response of voltage divider bias circuit of BJT.Measure midband gain, input impedance and output impedance.

4. Frequency response of voltage divider bias circuit of BJT using $R_E$ bypassed.
   Study frequency response of voltage divider bias circuit of BJT. Measure midband gain, input impedance and output impedance. Perform linearity test for given configuration.

5. Frequency response of emitter follower of BJT.
   Study frequency response of emitter follower of BJT. Measure mid band gain, input impedance and output impedance.

6. Design a R-C coupled amplifier of given gain using transistors in CE mode.
   i) Study the frequency response and calculate its bandwidth.
   ii) Connect a buffer (C-C amplifier) at the final stage and find its effect.

7. a) Construct a regulated power supply using a power transistor as a pass element and an OP-AMP as a comparator.

8. Design an active first and second order Butterworth filter and study its frequency response characteristics and find the cut-off frequencies.

9. Design of RC phase shift oscillator.

10. Design Integrator and Differentiator using OP-AMP and draw the transfer characteristics.

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# Semester-II

## Paper-ELC 201 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Signals and Systems

1. Introduction, Signal definition, different type of signals: analog & discrete. Time domain and frequency domain representation, periodic and aperiodic signals, energy and power signal, deterministic and non-deterministic signal, signals and vector analogy, othogonality of signal functions, some useful signal operations,
2. Sequences: classification based on length, symmetry, periodicity, energy, power, generation of sequences, special sequences, arithmetic operations on sequences.
3. Basis function and concept of generalized Fourier series: Fourier transform of some useful functions, convolution and correlation in time domain and frequency domain. Perseval's theorem, energy spectral density, essential bandwidth of a signal, energy of the modulated signal, time autocorrelation function and the energy spectral density, power spectral density, time autocorrelation function of power signals, Input and output power spectral densities, PSD of modulated signals.
4. LTI Systems: Convolution, graphical & analytical techniques, overlap & add method, sliding tape method, numerical problems on LTI systems, properties of convolution and interconnection of LTI systems, de-convolution, stability of systems, casual systems, recursive and non-recursive systems, difference equation, implementation of systems, Direct Form I and II structures, concepts of IIR & FIR systems, moving average system.
5. Discrete Fourier Transform: DFT and IDFT relationship, Twiddle factors, linear transformations, basic properties, , multiplication of DFTs, circular convolution, linear filtering using DFT, filtering of long data sequences, overlap and save method, overlap and method.
6. Fast Fourier Transform: Efficient computation of DFT, FFT algorithms, Radix-2 algorithm, decimation in-time and decimation-in-frequency algorithms, signal flow graph, butterflies, computation in one place, bit reversal, DFT computations using DIT & DIF algorithms.
7. Signal detection: Model of digital communication system, geometric interpretation of signals, Schwarz's inequality, concepts of orthogonality and orthonormality, Gram- Schmidt orthogonalization process, roles of multipliers and correlators, bank of correlators in noisy environment, channel characterization, likelihood functions, memory less channel, signal detection in presence of noise, maximum-likelihood detector, observation space, decision regions, conditional probability of symbol error, error function, complementary error function, correlation receiver, matched filter receiver, maximization of signal to noise ratio, properties of matched filter.

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## Paper-ELC 202 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

### Semiconductor Device

1. P-N junction diode, Depletion region and depletion capacitance, Abrupt junction, Diffusion potential and depletion layer width, linearly graded junctions, current voltage characteristics, Shockley equation, Diffusion capacitance, Junction breakdown, Tunnelling effect, Avalanche multiplication, Transient behaviour and noise. Varactor, Charge Storage diode, P – I - N diode.
2. Metal - Semiconductor Junction: Energy band diagram, Surface states, Depletion layer, Schottky effect, Current transport processes. Thermionic emission theory. Diffusion theory, Tunnelling current, Minority carrier injection ratio, calculation and Characterization of barrier height, Ohmic contact.
3. Bipolar transistor: Device modeling, Ebers - Moll model, Gummel – Poon model, Microwave transistor, Cut off frequency, Microwave characterization, Power transistor, Switching transistor, Hot – Electron transistor.
4. JFET and MESFET: Basic characteristics, uniform charge distribution, arbitrary charge distribution. Field dependence mobility, Two-region model, Saturated velocity model, Microwave performance,' Related field effect devices, current limitation, Multichannel FET.
5. Metal Oxide Semiconductor Devices: MOS capacitor, energy band diagrams, accumulation, flat band, mid band, depletion, inversion, Formulation of Poisson's equation: depletion approximation, exact solution, LFCV and HFCV plots, analytical expression of capacitances, Non-idealities in MOS capacitors, LFCV and HFCV in non-ideal MOS capacitors, MOS parameter extraction from CV measurements, bulk traps, interface traps, experimental procedures of trap density extraction, gate material, poly-depletion effect, Mid-gap work function gate material, review of high-K gate dielectric materials, MOSFET: derivation of I-V through gradual channel approximation, sub-threshold condition, sub-threshold slope, short channel effects in MOSFET, high-field and hot carrier effects, MOSFET scaling, SOI MOSFET :

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## Paper-ELC 203 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Digital Electronics and Mobile Communication

1. Extension review on logic gates (using transistor, diode etc) & logic families (detail circuit analysis of RTL, HTL, TTL, NMOS, & CMOS Families.
2. Combinational Circuit: Serial adder, Parallel adder, ripple carry adder, carry look ahead adder, BCD to seven segment decoder, parity encoder, Parity generator and checker, code conversion( BCD to Binary & Binary to Gray),Magnitude Comparator.
3. Sequential Logic system S-R, D, T, J-K flip-flop, Master –Slave connection, edge triggering & level Triggering, Timing diagram, Flip-Flop Conversion, Synchronous & asynchronous counter, Divide by N counter, Glich elimination, register, shift register, preset & clear functions
4. Implementation of logic gates using CMOS.
5. Multivibrator: Astable & Monostable (principle, circuits & operation) timer circuit using 555 timers.
6. Bipolar & MOS memories: RAM, ROM, Introduction of several ICs used as memory. Charge couple device, PLD devices.
7. D/A & A/D: - Specification of D/A converter, R-2R ladder type D/A converter, Successive approximation converter, The Dual slope converter.
8. Data communication networks and services, application and layered architecture, OSI model, IEEE 802.3 and IEEE 802.11, Network topologies, LAN and MAC, Data link control, Bridging, switching, addressing, Transmission systems, circuit switching networks, routing, signaling and traffic management, Packet switching networks, TCP/IP and Internetworking, network architectures and protocols, network security, ATM Networks, ISDN, BISDN, VoIP, VoDSL, Bluetooth, Wi-Fi WLAN, WAP and.
9. Wireless Communication: Wireless links, FDMA, CDMA, Base station and controller, Mobile Switching Centre, Call authentication and billing HLR, VLR, Queries etc. based mobile telephony.

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## Paper-ELC 204 (Theory)

## Elective-I

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

### Introduction to Electronics and Electronic waste management

1. Introduction to electronic materials.
2. Introduction to electronic devices and circuits: Basic concepts of diodes, transistors and its operation, diode circuits, amplifier, oscillator.
3. Introduction to digital electronics: number systems, binary addition, subtraction, combinational circuits, sequential circuits.
   Electronic Waste management: Definition of e-waste.
4. Measurement the e-waste flows: Calculation of sales and e-waste generated, Framework measuring e-waste flows.
5. The flow of e-waste: The e-waste trade, the international flow of e-waste, The illegal e-waste trade, Security implications. Electronic waste disposal systems, Chemicals of primary concern in e-waste,
   E-waste in india:
6. Growth of electrical and electronic industry in India, Environment concerns & health hazards,
7. Recycling e-waste: a thriving economy of the unorganized sector: Global trade in hazardous waste, Import of hazardous e-waste in India, E-waste economy in the unorganized sector, E-waste economy in the organized sector, E-waste projection and recycling in four major cities Delhi, Mumbai, Bangalore and Hyderabad.
8. Management of e-waste: E-waste legislation —introduction, Regulatory regime for e-waste - The Hazardous Waste (Management & Handling) Rules, 2003, The Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules, 2008,. Guidelines for Environmentally Sound Management of E-waste 2008, The Draft E-waste (Management and Handling) Rules, 2010.
9. The international experience: The Basel Convention, The Bamako Convention, The Rotterdam Convention, Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union. Government regulations on e-waste management in China and USA.
10. Case studies.

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## ELC-205 (Laboratory)

**Full Marks: 50**
**Credit: 4**

### Digital Electronics

1. Construction of simple arithmetic circuits-Adder, Subtractor.
2. Construction of two bit parity generator.
3. Construction of four bit comparator circuit.
4. Conversion of BCD to Binary & Vice Versa.
5. BCD to Decimal conversion to drive 7-segment display using MUX.
6. Design of RS, JK and MS flip flop.
7. Realization of MOD counter.
8. Realization of Ring counters.
9. Realization of Universal register using J-K & logic gate.
10. Realization of logic Gates using MOSFET.
11. Construct Astable Multivibrator using 555 timer.
12. Conversion of D/A using R-2R ladder.

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## ELC-206 (Laboratory)

**Full Marks: 50**
**Credit: 4**

### Semiconductor Device laboratory

1. Measurement of resistivity of a SI-wafer using four probe methods and to determine band gap of the sample using temperature sensitive conductivity measurements.
2. Determination of carrier concentration, mobility of a semiconductor sample using Hall measurements.
3. Estimation of metal-semiconductor barrier height using Al-Si/AU-Si schottky diodes using activation energy methods.
4. Application of thermionic technique to estimate M-S barrier height from I-V measurement.
5. Determination ideality factor and reverse saturation current of a Si/Ge diode
6. Estimation of carrier concentration of a N type semiconductor of a $P^{+}N$ junction from C-V measurement.
7. Study temperature dependent threshold voltage of a Field Effect Transistor.
8. To study the output and transfer characteristics of a FET.
9. Modelling of I-V characteristics of P-N junction and Schottky diodes using C.
10. Study of transient response of a Schottky diode at higher frequencies.
11. Study of the operational characteristics of (i) SCR (ii) DIAC (iii) TRIAC

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# Semester-III

## Paper-ELC 301 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Advance Electromagnetic Theory and Radiating Systems

1. The equation of continuity for time varying fields, Inconsistency of Amperes Law, Maxwell's Equations, Conditions at a Boundary Interface.
2. Wave propagation in free space, dielectric medium and conducting medium. Dielectric and Conductor. Depth of penetration. Reflection of wave by perfect conductor- normal and oblique incidence (Horizontal and Vertical Polarisation). Poynting theorm, Poynting vector, Flow of power.
3. Transmission Line: Frequency bands. Transients in transmission lines. Types of Transmission Line. Telegrapher's equation. Transmission Line Theory, Loss less transmission line, Terminated transmission line, Quarter wave transformer, Step up Transformer. Impedance matching, Stub matching, Smith Chart.
4. Guided Waves: Waves between parallel planes, TE modes, TM modes and TEM modes.
5. Wave Guides: Rectangular Wave Guide, Solutions of wave equations in rectangular coordinate.TM and TE modes in rectangular wave guide. Power transmission and losses in rectangular wave guide. Excitation of modes in rectangular wave guide. Characteristics of standard rectangular wave guide. Cylindrical Waveguide, Solutions of wave equations in cylindrical coordinate.TM and TE modes in cylindrical wave guide. Power transmission and losses in cylindrical wave guide. Excitation of modes in cylindrical wave guide. Characteristics of standard cylindrical wave guide.
6. Radiation: Potential functions and Electromagnetic field. Alternating current element, Herzian dipole, Radiation from quarter wave monopole or half wave dipole.
7. Antenna fundamentals: Fundamental parameters of antenna- Radiation Pattern, Radiation Power density, Radiation Intensity, Beam-width, Directivity, Antenna efficiency, Gain, Beam efficiency, Polarization, Input impedance, Antenna radiation efficiency, Antenna effective wavelength and equivalent areas, Max. Directivity.
8. Introduction to antennas: Resonant and non resonant antennas, Wire antenna, Loop antenna, Horn antenna, Parabolic reflector, Lens antenna, Helical antenna, Log periodic or frequency independent antennas. Travelling Wave antenna.
9. Radio Wave propagation: Ground waves, Space wave, Ionospheric wave and their characteristics, reflection and refraction of radio waves in ionosphere, critical frequency, skip distance, Maximum useable frequency, fading, secant law, duct propagation

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## Paper-ELC 302 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Communication Systems.

1. Analog communication systems: Introduction to basic elements of communication systems.
2. Signal transmission through linear systems: condition for distortion less transmission of signals through networks. Different types of distortion and their effect on the quality of output signals, transmission of transient signals, distortion analysis.
3. Amplitude modulation: Modulation principle and definitions, sideband and carrier power, generation of AM signal, demodulation of AM signal. Different type of modulator circuits, square law modulator, balanced modulator, etc.Demodulator basic principle of coherent detections, square law detectors, average envelope and peak envelope detectors. quadrature amplitude modulation (QAM), amplitude modulation: single sideband (SSB), generation of SSB signals, selective filtering method, phase shift method, demodulation of SSB-SC signals, envelop detection of SSB signals with a carrier (SSB+C), amplitude modulation: vestigial sideband (VSB), envelop detection of VSB+C signals, noise in AM receivers using envelope detection, concept of SNR.
4. Frequency and phase modulation: principles and definitions, relationship between frequency and phase modulations. Phase and frequency deviations, spectrum of FM signal, bandwidth considerations. Effect of modulation index on bandwidth, narrow band and sideband FM and PM principles, circuit for realization of FM and PM.
5. Principle of demodulation: different type of demodulator, discriminator, use of PLL etc. Radio transmitter: Basic block diagram of radio transmitter (AM and FM), Analysis of a practical circuit diagram used for medium power transmitter.
6. Radio receiver Basic block diagram of TRF, superhetrodyne principle, its advantages, Mixer principle and circuit.
7. Concepts of sampling in transmitting multiple band limited signals, Sampling theorem, channel bandwidth of PAM signal, crosstalk, concepts of signal reconstruction, quantization of signals, quantization error, PCM system, uniform and non-uniform quantization, companding, μ-law and A-law compressions, input-output characteristics, DPCM, DM, start-up, hunting, slope-overload error, ADM, algorithms for varying step size, Σ - Δ modulator, signaling formats –unipolar, bipolar, NRZ, RZ, Manchester and Gray with emphasis on power spectra, ISI, eye pattern, concept of equalization, linear transversal equalizer.
8. Digital modulation techniques: Digital modulation formats, coherent systems – BPSK, BFSK, QPSK & MSK: signal constellation, average probability of symbol error, derivation of transmitter and receiver, non-coherent systems – BFSK & DPSK: derivation of transmitter and receiver, comparison of binary and quaternary modulation systems, introductory idea of GMSK, QAM & OFDM.

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## Paper-ELC 303 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## VLSI Engineering

1. Introduction of VLSI: Evaluation of VLSI, VLSI design flow, Y-chart, Moor's law
2. Basics of MOSFET: MOS capacitor, operation and characteristics of MOSFET, small and large signal model of MOSFET, MOS capacitances, spice models of MOSFET, MOSFET scaling, small channel geometry effect.
3. Fabrication and Layout of MOSFET: Basic steps in IC fabrication (wafer preparation, epitaxial growth, oxidation, photolithography, diffusion, ion implantation, isolation, metallization, packaging and testing).NMOS fabrication, CMOS fabrication process, twin tub fabrication process. SOI technology, various design rules for layout. Stick diagram, Eular rule for layout.
4. Application specific IC: semi custom ASIC, Full custom ASIC, Standard cell based ASIC, Gate array based ASIC.
5. CMOS inverter: Resistive load ,CMOS inverter( operation and characteristics, delay calculation)
6. Digital VLSI: CMOS logic circuits, NAND & NOR Gates ,Complex logic circuits, CMOS Full Adder , CMOS Transmission GATE, Advanced CMOS Logic circuits; Sequential CMOS logic circuits; SR Latch circuit, clocked JK Latch/ Master-Slave JK, CMOS D-latch & Edge triggered flip-flop.
7. Analog VLSI Circuits: Analog VLSI design steps ; Basic building blocks of Analog VLSI chips, MOS switch , Voltage dividers ,CMOS Current source & sink ,current mirror,, CMOS Voltage references/voltage dividers [Basic circuits only], CMOS Differential amplifier; Output amplifiers [Basic circuits only], CMOS OPAMP, Switched capacitor filter.

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**Paper-ELC 304 (Theory)**

**Elective-II**

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## History of Electromagnetic and communication

1. Brief history to the development of electricity upto 18th century.
2. Evolution of Electromagnetic in 19th century: Ear& Experiments, Coulomb's Force Law, Galvanism and Electromagnetism, Electromagnetic Induction, Electrostatics and Magnetostatics, Ampere's Force Law, Ohm Law, Weber's Force Law, Faraday's Law, Electromagnetic Waves.
3. The Genesis of Maxwell's Equations: Faraday's Lines of Force, Physical Lines of Force, A Dynamical Theory of the Electromagnetic Field.
4. Maxwell, Hertz, the Maxwellians and the Early History of Electromagnetic Waves: Speculations of Electromagnetic Propagation Before Maxwell, Maxwell's Electromagnetic Theory of Light, Maxwell's Equations, Electromagnetic Waves, Oliver Heaviside, Heaviside's Life, Heaviside's Contributions- Transmission Lines, Maxwell's Equations, Operational Calculus, The Heaviside Layer.
5. Wireless before Marconi: Conduction Telegraph, Induction Telegraph, Electromagnetic Telegraph.
6. Nikola Tesla and His Contributions to Radio development: Invention of the Tesla Coil, Radio Controlled Vehicle, Colorado Springs Laboratory, Marconi and Braun Research, Long Island Laboratory.
7. J. C. Bose's Pioneering Work in Millimeter and Microwaves: A 60 GHz Transmission System, Development of the Receiver, Demonstration of Propagation, Demonstration of the Phenomenon of Refraction, Polarization, Photoelectric Effect, Measurement of Wavelength, Development of the Galena Detector, Biological Effects of millimeter Waves.
8. John Ambrose Fleming and development of wireless communication.
9. The Development of Wireless Telegraphy and Telephony and Transatlantic Wireless Communications : A Brief History of the Birth of Wireless, Experiments on Sparks and the Generation of Electromagnetic Waves, Early Receiving Devices, Continuous Wave Transmitters, Antenna Systems, Marconi's First Transatlantic Experiment, Marconi's Stations at Glace Bay, Transatlantic Experiments in the First Decade of the twentieth century- Marconi, Fessenden.
10. Modern wireless communication systems: Mobile communication, cell concept, wireless link, Base station and controller, Mobile switching centre, call authentication, HLR, VLR, Mobile network.
11. Brief history of optical communication.

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**Paper ELC-305(Practical)**

**Full Marks: 50**
**Credit: 4**

## VLSI Lab

1. Familiarization with SPICE simulation Model parameter.
2. Using SPICE simulate MOS Inverter with different loads (specifying Cox, μ, VTO, W, L etc of any standard MOS)
3. Using SPICE simulate a CMOS inverter. Obtain the transfer characteristics for different values of $\beta_n/\beta_p$
4. Obtain the transient response of CMOS Inverter for different values of $\beta_n/\beta_p$.
5. Draw logic circuit using schematic editor.
6. Familiarization of layout tools and design rules.
7. Design layout of a two input CMOS NAND and CMOS NOR gate using layout tool.
8. Introduction of FPGA, Implementation of logic gates using FPGA.
9. Introduction of VHDL programming.

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**Paper- ELC-306 (Laboratory)**
**Full Marks: 50**
**Credit: 4**

## Communication Laboratory

1. Generation and characteristic studies of Amplitude Modulation (AM) and Demodulation Techniques.
2. Generation and characteristic studies of Amplitude DSBSC and Demodulation Techniques.
3. Generation and characteristic studies of SSBSC and Demodulation Techniques.
4. Generation and characteristic studies of Frequency Modulation (FM) and Demodulation Techniques.
5. Generation and characteristic study of Pulse Amplitude Modulation (PAM).
6. Generation and characteristic study of Pulse Width Modulation (PWM).

### Optical lab

1. Numerical aperture of optical fibre.
2. Frequency response character of LDR.
3. Optical conversion of digital to analog signal.
4. Measurement of dimension of circular aperture by laser.
5. Study of broadening character of a pulse in an optical fibre.

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# Semester IV

## Paper-ELC 401 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Microwave and Power Electronics

1. Basic microwave concepts, Microwave and millimetre wave frequencies, General approach to microwave circuit analysis. Wave guide matching components, inductive, Capacitive and Resonant windows, Screw, Posts etc., Microwave Cavities, Rectangular, Circular and Semicircular Cavity resonators, Q-factor, Scattering matrix representation of microwave components , Attenuators and directional couples, Power divider, Isolator, Microwave hybrid circuits, Wave guide tees (E-plane, H-plane, Magic tees and their S-matrix calculation), hybrid rings, Wave guide Corners, bends and twists.
2. Microwave linear beam tubes: Klystrons, Reflex klystron, TWT, Microwave crossed field tubes: Magnetron.
3. Microwave bipolar junction transistor, hetrojunction bipolar junction transistor. Tunnel diode, Transferred electron devices, Gunn diode, limited space charge accumulation diode, Avalanche diode, IMPATT diode, TRAPATT diode.
4. Characteristics of solid state power devices: SCR, UJT, DIAC and TRIAC. Triggering Circuits, Converter, chopper, Inverters, AC regulators, Speed control of AC and DC motors. Three phase controlled rectifier, Switch mode power supply, uninterrupted power supply.

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## Paper-ELC 402 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Microprocessor and its Applications

1. Computer, Microprocessor and Microcomputer, Microprocessor application, 8085 μP architecture and its operation, Memory, Input and Output(I/O), Peripheral mapped and Memory –mapped I/O, addressing modes and Timing diagrams (for a few instruction), Data transfer between memory, 8085 μP and I/O.
2. Assembly language programming for one specific processor (say8085 μP), Arithmetic and logical processing, Branching and Stack related instructions, Time delay loop, Procedures, Data tables, Macro-modulator programming, Hard and Software integration.
3. Interrupts for 8085 μP, Basic interfacing concepts, Memory mapped and I/O mapped interfacing.
4. 8255 programmable peripheral interface, 8259 programmable interrupt controller, 8251 USART, Serial and parallel data transfer, ADC and DAC to interrupts, Interrupt circuits, keyboard and display interface.
5. Current loop interface, RS 232 serial interface standard, IEEE 488 standard, Error detection and correction.
6. Overview of 8086/8088 μP architecture,
7. 8051 microcontroller systems, introduction to RISC processor, ARM microcontroller.

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## Paper-ELC 403 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Control system & Instrumentation

1. Introduction**:** Concepts of Control Systems- Open Loop and closed loop control systems and their differences- Types of feedback control system.
2. Transfer Function Representation: Transfer Function of linear systems, Block diagram Reduction method, Signal flow graph, Mason's gain formula.
3. Time Response Analysis: Standard test signals - Time response of first order systems, Characteristic Equation of Feedback control systems, Transient response of second order systems, Time domain specifications – Steady state response - Steady state errors and error constants. P, PI and PID Controllers, Tachometer.
4. Stability Analysis: The concept of stability – Routh's stability criterion, Root Locus Technique: The root locus concept.
5. Frequency Response Analysis**:** Bode diagram, Phase margin and Gain margin, Stability Analysis from Bode Plots. Polar Plots, Nyquist Plot Stability analysis.
6. Transducers: Resistance, inductance, capacitance, piezoelectric, thermoelectric and Photoelectric transducer, Hall effect measurement, Measurement of displacement, velocity, acceleration, force, torque, strain, temperature, pressure, flow, humidity, thickness, pH and position.
7. Measuring equipments: Measurements of R, L and C. Digital Storage Oscilloscopes, Logic state analyzer, Signal generators, Distortion analyzer, Spectrum analyzer, Instrumentation amplifiers, and Radio telemetry.
8. Analytical Instrument: Biomedical instruments: ECG, blood pressure measurements, Spectrophotometers, Electron microscope.

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## Paper-ELC 404 (Theory)

**Full Marks: 50**
**Credit: 4**

**(University Written Examination-40 Marks & Internal Assessment- 10 Marks)**

## Optical Communication and Information Processing

1. Perturbation theory: Time independent and time dependent, Fermi's Golden rule for transitions.
2. Application of optical fiber in communication and its Advantages, Basic principles of light propagation, Optical fibers - modal propagation-Ray Model, Wave Model.
3. Attenuation in optical fiber, Signal distortion on optical fibers Material Dispersion, Intermodal and Intramodal, Loss Mechanism in Optical Fibers-Absorption and Scattering, Fresnel Reflection, Micro bending & Macro bending radiation, Connector types and Splices, Misalignment and Mismatch losses, The Optical Directional Copular.
4. Optical sources: LEDs, Direct band gap semiconductors, Spontaneous emission, LED structures, Internal quantum efficiency, Linearity, Radiation pattern and spectra, Modulation characteristics, Transient response; Lasers: Stimulated emission and lasing, Laser structures, Radiation pattern and spectra, Narrow-line width lasers, Modulation characteristics: Threshold current and its temperature sensitivity, Turn-on delay, Linearity; Gas Laser, Semiconductor laser.
5. Pulse coding principle, Multiplexing and de-multiplexing of signal: Time Division Multiplexing and De-multiplexing, Wavelength Division Multiplexing and De-multiplexing,
6. Photo receivers, Photoconductors, Semiconductor Photodiodes, Photo Transistors, noise. Optical link design, power penalty. SONET/SDH, DWDM, optical switches, Fiber Amplifiers, EDFA, DRA, WDM networks and components and Optical CDAMA.
7. Parallel Optical Computation and data processing: Digital optics, Optical logic gates, Half-adder, Full-adder
8. Communication with laser as source (Channel based and channel less), LlDAR.
9. Non-linear Optics: Non-linearity of medium, second and higher harmonic generation, phase matching condition, frequency addition and frequency subtraction.

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**Paper: ELC – 405**
**Full Marks: 50**
**Credit: 4**

## Microprocessor Programming Laboratory

1. Assembly language/machine language programming of 8085/8086 μP based on arithmetic and logical processing, time delay loop etc.
2. Memory interface with 8085/8086 CPU using IC 8255A.
3. Test and program the peripheral IC 8255A in different modes using 8085 μP.
4. Interface 8255/8259/8279/with 8085/8086 microprocessor.
5. ADC interface with 8085/8086 μP.
6. Keyboard and display interfaces with 8085/8086 μP.
7. Interface a stepper motor with 8085/8086 μP.

**Paper: ELC – 406**
**Project Work**
**Full Marks: 50**
**Credit: 4**

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## BOOKS RECOMMENDED


1. Mathematical methods for Physicists, G. Arfken.
2. Introduction to Mathematical Physics, Harper.
3. Mathematical Method (2nd et), Potter.
4. Advanced Engineering Mathematics, M.D: Greenberg.
5. Complex Variables and Applications, R V Churchill.
6. Theory and problems on Laplace Transforms, Spiegel.
7. Numerical Analysis, Scarbarroh.
8. Optics, Ajoy Ghatak.
9. Quantum Mechanics, Agarwal and Hariprakash.
10. Quantum Mechanics, S.N. Ghoshal.
11. Quantum Mechanics, Ghatak and Loknathan.
12. Quantum Mechanics, Schiff.
13. Problems in Elementary Quantum Mechanics, S. Bala Subranium.
14. Solid State Physics, D.L. Bhattacharya.
15. Introduction to Solid State Physics, Kittel.
16. Solid state physics, Dekker.
17. Electrical Engineering Material, Dekker.
18. Solid State Electronic Devices, Streetman.
19. Solid State Electronic Engineering Materials, S.O. Pillai.
20. Microeletronic Circuits and Devices, Horenstein.
21. Microelectronic Circuits, AS. Sedra and KC. Smith.
22. Microelectronics, Millman and Taub.
23. Circuit theory, Chattopadhayay and Rakshit
24. Network analysis, Van Valkenberg.
25. Electronic circuit analysis and design, Hyat and Neudeck.
26. Basic Circuit Theory, L.P Huelsman
27. Electronic Devices and Circuit Theory, Boylested and Nashelaky.



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28. Electronic Devices and Circuits, Mottershed.
29. Integrated Electronics, Millman and Halkias.
30. Electronics Principles, Malvino.
31. Electronics Fundamental and Application, Chattopadhyay and Rakshit
32. Application and Design of Analog Integrated Circuits, Jacob.
33. Operational Amplifiers and Linear Integrated Circuits, Coughing and Discolt
34. OP-AMPS Linear Integrated Circuits, Gaykwad.
35. Introduction to Electrodynamics, Griffith.
36. Electromagnetic Waves & Radiating Systems, Jordan and Baihnan.
37. Microwave propagation and technique, D.C. Sarkar
38. Microwave Device and Circuits, Liao.
39. Elements of Engineering Electrodynamics, M.M. Rao.
40. Networks, Lines and Fields, Ryder.
41. Laser, Ghatak and Thyagarajan.
42. Optical Electonics, Ghatak and Thyagarajan.
43. Semiconductor Opto-electronics, Pallab Bhattacharya.
44. An introduction to opto-electronics, Wilson and Hawkes.
45. Laser Electronics, Vereyan.
46. Digital computer Design, M. Mano.
47. Fundamentals of Computers, Rajaraman.
48. Introduction to Digital Computer Design, Rajaraman and Radhakrishnan.
49. Algorithms +Data Structures = Programs, Writ.
50. Computer Networks, Tanenbanm.
51. Computer Networks : Protocols, Standards and Interfaces, Black
52. Local Area Network and their applications, Tangney and Omahony.
53. IBM PC/XI: Basic programming and Applications, Boylestad and Nashelsky.
54. Digital Electronics, Gothmann.
55. Digital Principles and Applications, Malvino and Leach.

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56. Digital Electronics, Malvino.
57. Digital Computer Electronics, Malvino and Brown.
58. Digital Systems: Principales and practices, Tocci.
59. 8000 to 8085 Introduction to Microprocessor for Engineer and Scientists, Ghosh and Sridhar.
60. Microprocessor Architecture, Programming, and Applications with the 8085, Gaonkar.
61. Labortory Manual: experiments on, microprocessor, AK Mukhopadhyay.
62. Communication Systems, Kennedy.
63. Communication Systems, B. Carlson.
64. Principle of Communication Systems, D. Schilling and H. Taub.
65. Signal Processing and Linear Systems: B.P.Lathi.
66. Communication Systems: B.P.Lathi.
67. Analog and Digital Communications, Roden.
68. Electronic communication, Roddy and Coolen.
69. Modern Electronic Instrumentation and Measurement Techniques, Helfrick and Cooper.
70. Modem principles of Measurements and Instrumentation, Morris.
71. Transducer and Instrumentation, Murthy.
72. Electronic Measurements, Terman and Peti.
73. Semiconductor Devices: S.M.Sze.
74. Digital Signal Processing: Principles, algorithms and applications,J.G. Proakias & D.G.Manolakis, PHI
75. Digital Signal processing: Hands on approach, C. Schuler and M. Chugani, TMH
76. Discrete Time Signal Processing, A.V. Oppenheim and R.W. Schaffer, PHI
77. Theory and applications of Digital Signal Processing, L.R. Rabiner and B. Gold, Prentice Hall.
78. Fiber optics and Optoelectronics, R.P. Khare, Oxford Press

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79. Optical Fiber Communication Principles and Systems, A. Selvarajan, S.Kar and T.Srinivas, TMH
80. Optical Fiber Communications, Keiser, G. McGraw Hill, Int. Student Ed.
81. Fiber Optic Communication systems, G.P.Aggarwal,Wiley Eastern
82. Introduction to Fiber Optics , A.Ghatak and K.Thyagrajan, Cambridge Univ. Press
83. Introduction to Optical Electronics, K.A. Jones, Harper & Row
84. Principles and Applications of Optical communications, M.K.Liu, McGraw Hill
85. Power Electronics , N.Mohan, J.M. Undeland, and W.P. Robbins, John Wilay and Sons, 2003-2004.
86. Power Electronics, M.D. Singh,K.B.Khanchandani, Tata McGrawHill Publishing Co
87. VLSI Fabrication Principles, S.K. Gandhi, John Willey & Sons.
88. VLSI Technology, S.M. Sze, McGraw Hill,Int. Book Company.
89. Modern VLSI Design, W.Woulf, Pearson
90. Principles of CMOS VLSI Design, N. H.E. West and K.Eshranghian, PHI
91. Basic VLSI Design, D.A. Pucknell K. Eshraghian, PHI.
92. Digital Integrated Circuit Design, K. Martin, Oxford
93. Introduction to VLSI Systems, Mead C & Conway L.Addison Wesley Pub.
94. Analysis & Design of Digital Integrated Circuits, Hodges & Jackson,McGraw Hill Int. Pub.
95. Integrated Circuit Engineering, Glasser, A.B Sharpe, S McGraw Hill Int. Pub.
96. Large Scale Integration, Howes M.G.Morgan D.V,J. Wiley.
97. Digital Signal Processing: Principles, algorithms and applications,J.G.Proakias & D.G. Manolakis, PHI
98. Digital Signal processing: Hands on approach, C. Schuler and M. Chugani, TMH
99. Discrete Time Signal Processing, A.V. Oppenheim and R.W. Schaffer, PHI

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100. Theory and applications of Digital Signal Processing, L.R. Rabiner and B. Gold, Prentice Hall.
101. CMOS VLSI Design, N.H.E. Weste, K. Eshranghian, Addison Wesley
102. Digital Design Principles, J. Wakerley,Prentice Hall of India.
103. Digital Sytems testing and testable design, MIron Abromovici, Melvin Breuer, Arthur Freedman, Jaico Publishing House
104. VHDL, D. Perry,McGraw Hill Int. Edition.
105. Computer Data Communication, Williams
106. Computer Networking, Tannunbam, PHI
107. Electronic Properties of materials, R.E. Hummel
108. Electronic Properties of materials, David Jiles
109. Solid State Physics, Dekkar
110. Introduction to Solid State Physics, C.Kittle
111. Solid State Physics, Ashcroft, Mermin
112. Principles of Electronic materials & dev, S.O. Kasap

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