

SoS in Electronics & Photonics
Pt. Ravishankar Shukla University, Raipur Chhattisgarh

ENTRANCETEST- 2025
FOR Ph.D. in ELECTRONICS SYLLABUS

UNIT-I

Introduction to Semiconductor, energy bands in solids, **Semiconductors:** Direct and indirect band gap methods to determine the Forbidden gap, mobility and conductivity, intrinsic and extrinsic semiconductor, Impurities, carrier concentration, electrical properties of Ge and Si, experimental methods to study the electrical parameters, Drift and Diffusion, Hall effect, electrons and phonons in semiconductors. Zener diode, Tunnel diode, Metal semiconductor junction-Ohmic and Schottky contacts, Characteristics and equivalent circuits of JFET, MOSFET. Low dimensional semiconductor devices – quantum wells, quantum wires, quantum dots. High Electron Mobility Transistor (HEMT), Solar cells – I-V characteristics, fill factor and efficiency, Solar cell materials and their properties. LED, LCD and flexible display devices. Emerging materials for future Devices: Graphene, Carbon Nano tubes (CNT), ZnO, SiC etc.

UNIT-II

IC fabrication-crystal growth, epitaxy, oxidation, lithography, doping, etching, isolation methods, metallization, bonding, Thin film deposition and characterization Techniques: XRD, TEM, SEM, EDX, Thin film active and passive devices, MOS technology and VLSI, scaling of MOS devices, NMOS and CMOS structures and fabrication, Characteristics of MOS transistors and threshold voltage, NMOS and CMOS inverters, Charge-Coupled Device(CCD) – structure, charge storage and transfer,

UNIT-III

Superposition, Thevenin, Norton and Maximum Power Transfer Theorems, Network elements, Network graphs, Nodal and Mesh analysis. Laplace Transform, Fourier Transform and Z-transform. Time and frequency domain response, Passive filters, Two-port Network Parameters : Z, Y, ABCD and h parameters, Transfer functions, Signal representation, State variable method of circuit analysis, AC circuit analysis, Transient analysis, Zero and Poles, Bode Plots. Continuous time signals, Fourier Series and Fourier transform representations, Sampling theorem and applications, Discrete time signal, Discrete Fourier transform (DFT), Fast Fourier transform (FFT).

UNIT-IV

Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors and FETs, operating point and stability, Amplifiers, Classification of amplifiers, Concept of feedback, Hartley, Colpitt's and Phase Shift oscillators, Operational amplifiers(OPAMP) - characteristics, computational applications, comparators, Schmitt trigger, Instrumentation amplifiers, wave shaping circuits, Phase locked loops, Active filters, Multivibrators, Voltage to frequency convertors (V/F), frequency to voltage convertors (F/V).

UNIT-V

Logic Families, Logic Gates, Boolean algebra and minimization techniques, Combinational circuits, Programmable Logic Devices (PLD), CPLD, flip-flops, memories, Sequential Circuits: Counters – Ring, Ripple, Synchronous, Asynchronous, Shift registers, multiplexers and demultiplexers, A/D and D/A converters, Analysis and Design of fundamental mode state machines: State variables, State table and State diagram. Sequential PLD, FPGA.

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UNIT-VI

Introduction of Microprocessor 8086: Architecture, Addressing modes, instruction set, interrupts, Programming, Memory and I/O interfacing.

Introduction of Microcontrollers – 8051 for embedded systems, Architecture and register set of Microcontroller 8051, Addressing modes, Instruction set of 8051 – Data transfer instructions, Arithmetic instructions, Logic instructions, bit level and byte level control transfer instructions, 8051 assembly programming – stack operations, subroutines, interrupts, 8051 programming as timer/counter, 8051 serial communication, 8051 interfacing RS232, LED/LCD display, Keyboard, Stepper motor.

UNIT-VII

Light as Electromagnetic wave, Polarization of Light, Principle of superposition, Interference, Diffraction, Scattering, Photon nature of light, Silicon P-N photodiodes, heterojunction photodiodes, Schottky barrier diode, P-I-N photodiodes, avalanche photodiodes, and phototransistors. Molecular materials, Organic Semiconductors, Electronic states in conjugated molecules, Conjugated polymers, Basics of OLED, Solar cell research: technology (silicon, organic, Dye sensitized, perovskites), applications and limitations. LED materials, Solar cell materials and their properties. Solar cell research: technology (silicon, organic, Dye sensitized, perovskites), applications and limitations. Solar Simulators.

Non Linear Optics Kerr effect, Pockels effect, Faraday effect, Electro-Optic Modulator. Silicon photonics, Silicon on Insulator (SOI) waveguides or nanowires

UNIT-VIII

Basic principle of lasers, laser pumping, stimulated emission, light amplification, threshold condition, Einstein's coefficient, laser rate equations, mode locking and Q-switching of lasers. Ruby Laser, He-Ne laser, Ar-ion laser, CO₂ laser, Solid State Laser: Host material and its characteristics, doped ions Nd:YAG laser, Liquid laser: Dye laser, Semiconductor laser

Laser in manufacturing, laser cutting of material, laser marking, laser transmitter, measurement of distance through Laser

Transmission lines and waveguides – line equations, impedance, reflections and voltage standing wave ratio, rectangular waveguides. Antennas – retarded potential and Hertzian dipole, halfwave antenna, antenna patterns, radiation intensity, gain, effective area and Friis's free space receiver power equation.

Microwave Sources and Devices - Reflex Klystron, Magnetron, TWT, Gunn diode, IMPATT diode, Crystal Detector and PIN diode.

Radar – block diagram of Radar, frequencies and power used, Radar range equation.

UNIT-IX

Analog modulation and demodulation - AM, FM and PM, Principle of super heterodyne receiver, Random signals, noise, noise temperature and noise figure, Basic concepts of information theory, Error detection and correction, Digital modulation and demodulation – PCM, ASK, FSK, PSK, BPSK, QPSK and QAM, Time and Frequency-Division Multiplexing, Multiple Access techniques, Data Communications – Modems, Codes, Principles of Mobile and Satellite Communication, Optical communication, Optical sources - LED, spontaneous and stimulated emission, semiconductor Lasers, Optical fibers – attenuation and dispersion characteristics, Bandwidth, Wavelength division multiplexing.

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Fundamentals of Internet of Things (IoT) for communication.

UNIT-X

Power devices – characteristics of SCR, DIAC, TRIAC, power transistors, Protection of thyristors against over voltage and over current. SCR triggering - dv/dt and di/dt , triggering with single pulse and train of pulses, A.C. and D.C. motors - construction and speed control. Switched Mode Power Supply (SMPS). Uninterrupted Power Supply (UPS).

Open loop and closed loop control system, Block Diagram reduction techniques, transfer function and signal flow diagram, Stability criterion: Routh-Hurwitz and Nyquist plot, On-off controller, Proportional (P), Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers. Introduction to ANS Technology-Models of a neuron, neural networks, viewed as directed graph, feedback from neurons to ANS, Learning and training- Hebbian, memory based, competitive, error-correction and learning. Assignment problem supervised and unsupervised learning. Network architectures-Single layered- feed forward networks, multi-layered feed forward networks.

UNIT-XI

Continuous Time Signal Analysis: Classification of signals and systems, some ideal signals, energy signal, Power signals, energy and power spectral densities.

Fourier Series, Complex Fourier Spectrum, The Fourier Transform, Continuous Spectrum, Fourier Transform involving Impulse Function, Properties of Fourier Transform, Fourier Transform of Periodic Functions, Convolution, Sampling Theorem.

Discrete Time Signals, Systems, Z-Transform, Discrete Fourier Transform, Fast Fourier Transform, Digital IIR filter. Digital FIR filter. Biomedical Instruments – Introduction to biomedical instrumentation, sources of bioelectric potentials, electrodes- electrode theory, biopotential electrodes, biochemical transducers, cardiovascular measurements- electrocardiography, measurement of blood pressure, blood flow and heart sound, Sensors for IoT applications.

Reference Books

1. Adel S. Sedra and K.C. Smith, "Microelectronic Circuits", 5th edition, Oxford University Press, 2004.
2. Schilling, Belove, "Electronic Circuits", Third edition, Tata McGraw-Hill, 2006
3. D.M. Pozar "Microwave Engineering", Publisher: Wiley
4. Symon Haykins "Principles of Communications Systems", John Wiley
5. Bookhive's Net Electronics Sciences Paper
6. Fundamentals of Photonics, by B.E.A. Saleh and M.C. Teich Wiley India Pvt Ltd; 2nd edition
7. Trueman's UGCNET/SET General Paper I M. Gagan and Sajit Kumar
8. Optical Electronics- Ghatak Thyagarajan, University Press
9. A Textbook of Electrical Technology (Volume-II) - B.L. Theraja & A.K. Theraja, S Chand & Co. Ltd (2006)
10. Electronic Devices and Circuit Theory, 9th ed. Boylestad & Nashelsky PHI
11. Microelectronics- Jacob Millman, Arvin Grabel, Tata McGraw-Hill
12. Physics of Semiconductor Devices: Shur PHI
13. M. Moris Mano, Digital Design, PHI Learning Pvt. Ltd. New Delhi.
14. Networks and System - D. Roy Choudhary, New Age International

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15. Microprocessor Architecture Programming-Ramesh S. Gaonkar & Application with 8085/8080 Penram Int. Pub
16. Microwave Devices and Circuits-Samuel Y. Liao, PHI Pub
17. Yu Cheng Liu, Glenn A. Gibson, Microcomputer systems: The 8086/8088 family architecture, programming and design, Prentice Hall of India, New Delhi.
18. Design with PIC Microcontrollers-John B. Peatman, Pearson Education Asia
19. PIC Microcontrollers: An Introduction to Microelectronics, Martin P. Bates, Elsevier.
20. D.V.S. Murti, Transducers and Instrumentation, PHI Learning Pvt Ltd, New Delhi.
21. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, Instrumental Analysis, CENGAGE Learning, Indian Edition.
22. Handbook of Biomedical Instrumentation Khandpur
23. Artificial Neural networks-B. Yagna Narayan
24. Digital Signal Processing-A.V. Oppenheim & Schafer. PHI
25. Signal and System-Nagrath, Sharan and Ranjan. McGrawhill Publishing
26. Signal and Systems-Rodger E. Ziemer. Continuous and Discrete 2nd ed. Maxwell Macmillan Int. Edition

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