Punyashlok Ahilyadevi Holkar Solapur University, Solapur

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।

NAAC Accredited-2015
'B' Grade (CGPA 2.62)

Name of the Faculty: Science and Technology

CHOICE BASED CREDIT SYSTEM

Structure and Syllabus: Physics (Applied Electronics)

Name of the Course: M. Sc.- II (Sem. III & IV)

(Syllabus to be implemented from w.e.f. June 2021)

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

M.Sc – Physics (Applied Electronics)

Choice Based Credit System

w.e.f June 2021-22

Semester	Code	Title of the Paper	Semester exam			L	T	P	Credits
Third		**Hard core**							
AE	**HCT3.1**	Semiconductor Physics	80	20	100	4		-	4
	HCT3.2	Atomic and Molecular Physics	80	20	100	4		-	4
		Soft core (Any one)	80	20					
	SCT3.1	Communication System	80	20	100	4		-	
	SCT3.2	Biomedical Instrumentation	80	20	100			-	4
		Tutorial			25		1		1
		Open elective (Any one)	80	20					
	OET3.1	Communication & Digital Electronics	80	20	100			-	4
	OET3.2	Power Supplies	80	20	100	4		-	
		Practical							
	HCP 3.1	Practical HCP 3.1	40	10	50	-	-	2	2
	HCP3.2	Practical HCP 3.2	40	10	50	-	-	2	2
	SCP 3.1	Practical SCP 3.1	40	10	50	-	-	2	2
		Open elective (Any one)							
	OEP3.1	Practical OEP3.1	40	10	50	-	-	2	2
	OEP3.2	Practical OEP3.2	40	10	50	-	-	2	
		Total for third semester	**480**	**120**	**625**				**25**
		Skill Enhancement Course (Any One)							
	SEC3.1	PCB Design and Manufacturing using Proteous CAD	--	--	--	--	--	--	4*
	SEC3.2	LabVIEW	--	--	--	--	--	--	
Four		**Hard core**							
AE	**HCT4.1**	Semiconductor Devices	80	20	100	4		-	4
	HCT4.2	Nuclear and Particle Physics	80	20	100	4		-	4
	HCT 4.3	Microwave Devices & Circuits	80	20	100	4		-	4
		Soft core (Any one)	80	20				-	4
	SCT4.1	Microcontrollers & Interfacing	80	20	100	4		-	
	SCT4.2	Microelectronics	80	20	100	4		-	
		Tutorial			25		1	-	1
	MP4.3	Major Project/Internship*	160	40	200	-	-	-	8
		Total for four semester	**480**	**120**	**625**				**25**
	Total								**100**

L = Lecture T = Tutorials P = Practical IA= Internal Assessment
4 Credits of Theory = 4 Hours of teaching per week
2 Credit of Practical = 4 hours per week
HCT = Hard core theory
SCT = Soft core theory
HCP = Hard core practical
SCP = Soft core practical
OET = Open elective theory
OEP = Open elective practical
MP = Major project (In-house/ Industry sponsored)
***Internship: Internship at any Electronics/Software company**
***SEC: Skill Enhancement Course -04 Credits**
***MOOC/ SWYAM Course: Student can opt from MOOC/ SWYAM platform as an Ad On course**

***MP = Major project Assessment**

- **160 Marks-University Examinations (Viva Dissertation, Project Progress, evaluation)**
- **40 Marks- Internal Performance Evaluation (15 Marks: Presentations, 15 Marks :Performance & 10 Marks: Attendance)**

M.Sc-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)
HCT - 3.1: SEMICONDUCTOR PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

COURSE CODE: HCT 3.1 (60 lectures, 4 credits)
Course Objectives:

- To understand fundamentals of semiconductor physics.
- To understand basic knowledge of energy bands and charge carriers in semiconductors.
- To understand role of excess carriers in semiconductors.
- To understand dynamics of charge carriers and lattice and semiconductor interfaces.
- To understand semiconductor crystal growth process.

Learning outcomes:
Students should be able to

- Students will come to know fundamentals of semiconductors, bonding forces, energy bonds, carrier concentrations, electrical conductivity and mobility.
- Students will know optical absorption phenomenon, recombination of electrons and holes, diffusion process of carriers.
- Students will know behaviour of periodic potential, group velocity of electrons, inverse effective mass, force equation, dynamics of electronics and holes, Schottky barriers surfaces and interfaces.

Unit 1. Energy bands and charge carriers in semiconductors (15)

Bonding forces and energy bands, direct and indirect band gap semiconductors, variation of energy bands with alloy composition, effective mass, electrons and holes in quantum wells, the Fermi level, electron and hole concentrations at equilibrium, temperature dependence of carrier concentrations, electrical conductivity and mobility, high field effects.

Unit 2. Excess carriers in semiconductors (15)

Optical absorption, direct recombination of electrons and holes, indirect recombination, trapping, steady state carrier generation, quasi Fermi levels, diffusion process of carriers, diffusion and drift of carriers, diffusion and recombination: the continuity equation, steady state carrier injection, diffusion length, the Haynes-Shockley experiment.

Unit 3. Dynamics of charge carriers and lattice, and Semiconductor Interfaces (15)

Electrons in a periodic potential, group velocity of electrons, inverse effective mass tensor, force equation, dynamics of electrons and holes, effective mass theory of impurities, the vibrational specific heat, thermal expansion, thermal conductivity. Schottky barriers, rectifying contacts, ohmic contacts, surface and interface states and their effects on barrier height, acceptor and donor surface states, Fermi level pinning

Unit 4. Semiconductor crystal growth process (15)

Nucleation and growth theory, atomic bonding, formation energy of clusters, supersaturation, supercooling and volume energy, stability of small nuclei, the formation energies of liquid nuclei and crystalline nuclei, nucleation rates, the growth of crystal surfaces, growth of bulk semiconductors by zone melting and zone refining, Czochralski and liquid encapsulation techniques, growth of epitaxial layers by LPE, VPE and MBE techniques**.**

Reference Books

1. Physics of Semiconductor Devices by Dilip K. Roy, Univ. Press (India) Pvt. Ltd., 1992.
2. Physics of Semiconductor Devices by S.M. Sze
3. Solid state electronic devices by B. G. Streetman.
4. Semiconductors by R. A. Smith, Cambridge Univ. Press.
5. Solid state electronics by Wang, Mc. Graw Hill.
6. Crystal Growth by B. R. Pamplin (ed.)
7. Growth of Single Crystal by R. A. Laudise.
8. Growth of crystals from solutions by J. C. Brices
9. Solid State and Semiconductor Physics by M.C. Kelvey.
10. Modern techniques in metallography – D.G. Brandon, Butterworths (1966)

M.Sc-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)
HCT - 3.2: ATOMIC and MOLECULAR PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

COURSE CODE: HCT 3.2 (60 lectures, 4 credits)

Course Objective

- To describe the atomic spectra of one and two valance electron atoms.
- To explain the change in behaviour of atoms in external applied electric and magnetic field.
- To explain rotational, vibrational, electronic and Raman spectra of molecules.
- To describe electron spin and nuclear magnetic resonance spectroscopy and their
- applications.

Learning Outcome

Students are able to

- Master both experimental and theoretical working methods in atomic and molecular physics for making correct evaluation and judgments.
- Developing analytical, laboratory and computing skills through problem solving, laboratory & computer based exercises which involve the applications of atomic and molecular physics.
- Carry out experimental and theoretical studies on atomic and molecular physics with focus on structure & dynamics of atoms and molecules.
- Account for theoretical models, terminology & working methods used in atomic and molecular physics.
- To successfully apply the theoretical techniques presented in course to practical problems.

Unit-I Atomic structure and Atomic Spectra (20)

Revision of hydrogen atom (wave functions, orbital and spin angular momentum, Quantum states of an electron in an atom, magnetic dipole moment, Electron spin, spin-orbit interaction, fine structure, spectroscopic terms). Origin of spectral lines, selection rules, Stern Gerlach experiment, some features of one-electron spectra. Relativistic corrections for energy levels of hydrogen atom, Multi-electron atoms: Exchange symmetry of wave functions, Pauli`s exclusion principle, electron configuration, Hund’s rule etc. L-S coupling, J-J coupling.

Unit-II Atoms in an electromagnetic field (10)

Spectral lines, Selection rules, Some features of two-electron spectra, fine structure spectra, hyperfine structure spectra, X-ray spectra, Stark effect, Zeeman effect and Paschen-Back effect

Unit-III Molecular Structure and Molecular Spectra (20)

Covalent, ionic and van der Waal bonding, Valence bond and molecular orbital approach for molecular bonding and electronic structure of homonuclear diatomic molecules, pairing and valency, heteronuclear diatomic molecules, hybridization, ionic bonding, electro-negativity, electron affinity. Electronic structure of polyatomic molecules: hybrid orbitals, bonding in hydrocarbons.

Rotational levels in diatomic and polyatomic molecules: Born – Oppenheimer approximation, Rigid and non-rigid rotation, selection rules. Vibrational levels in diatomic and polyatomic molecules: Morse oscillator model for vibrational levels. Vibration spectrum of diatomic molecule, vibration-rotation spectra (P, Q, R branches). Electronic spectra of diatomic molecules: Frank-Condon principle.

Unit-IV Atomic and molecular spectroscopic methods (10)

Atomic and Molecular Polarizability, Molecular vibrations and group theoretical selection rules for infra-red and Raman transitions, Infra-red spectroscopy and Raman spectroscopy for vibrational level determination. Microwave spectroscopy and Rotational Raman spectroscopy for rotational level determination, Electronic spectroscopy for molecular structure determination. Nuclear Magnetic resonance and Electron spin resonance

Text Book: (Unit-I &II)

1. Quantum Physics, Robert Eisberg and Robert Resnick, (John Wiley and Sons).

Reference Books: (Unit-I &II)

1. Introduction to Atomic Spectra, H. E. White, (McGraw Hill International Ed.)
2. Perspectives of Modern Physics, Arthur Beiser, (McGraw Hill International Ed.)
3. Physics of Atoms and Molecules, B.H. Bransden and C.J. Joachain (Pearson).
4. The Physics of Atoms and Quanta Introduction to Experiments and Theory
   Authors: Haken, Hermann, Wolf, Hans Christoph

Text Book: **(Unit-III & IV)**

1. Molecular Spectra and Molecular Structure, Gerhard Herzberg, (D. Van Nostrand Company, Inc.)

Reference Books: (Unit-III & IV)

1. Molecular Spectra and Molecular Spectroscopy (Vol. 1), G. Herzberg
2. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, (Tata, McGrawHill Publishing Company Limited)
3. Molecular Spectroscopy – J.M. Brown, Oxford University Press (1998).
4. Modern Spectroscopy, J.M. Hollas (John Wiley).
5. Molecular Quantum Mechanics, P.W. Atkins and R. Freidman (Oxford University Press)
6. Quantum Chemistry, I. N. Levine (Wiley)

M.Sc-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)
SCT - 3.1: COMMUNICATION SYSTEMS
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

COURSE CODE: SCT 3.1 (60 lectures, 4 credits)
Course Objective:

- Communication is an inseparable part of modern life. The use of analog communication in detail with block diagram, detail circuits and introduction to digital communication are highlights of this course.
- The syllabus designed in this paper is useful to science student to understand the application of Electronics Communication.

Course Outcome:

- The Student will be aware of analog and digital communication systems after pursuing this course.

Unit 1: A.M. Transmitters and (15)

Block diagram of High and Low level modulated A.M. Transmitters. The exciter, Class A, Class B, Class C modulated power amplifier circuits of sidebands and sideband transmission, Balanced modulators.

Block diagram of A.M. receiver and A.M. Detector, (circuits to be discussed), Class B audio amplifier.

Unit 2: F.M. Transmitters and Receivers (15)

F.M. radio frequency band, Block diagram of F.M. transmitter, block diagram of VCO, frequency doubler, tripler.

Block diagram of F.M. receiver, F.M. detector (Slope and dual slope detector), PLL as FM detector. (Circuits to be discussed)

Unit 3: Digital Modulation and Techniques (15)

Pulse: Modulation systems: Sampling theorem, low pass and band pass signals (PAM, PWM, PPM, Amplitude shift keying, Frequency shift keying, Phase shift keying, Differential phase shift keying. Quantization of signals,

Delta modulation (Basic introduction).Modulation and Demodulation Circuits, TDM, FDM, Cross talk in TDM , Pulse time modulation , Generation of PTM , Demodulation of PTM , Transponder, TDMA, PDMA, CDMA

Unit 4: Multiplexing & Multiple Access Techniques (15)

Unipolar, Bipolar, RZ, NRZ, Transmission modes, Simplex, Half duplex, full duplex, Asynchronous transmission.

Text Books:

1. Communication System, Analog and Digital R.P. Singh and S.D. Sapre (THM)
2. Electronic Telecommunication System (4th Edition) George Kennedy and Bernard Devise (MGH)

References

1. Digital and analog communication system – Sam Shanmugam, Wiley Student Edition, 2008 reprint.
2. Data communication – William Schweber, McGraw-Hill, 1988
3. Digital communication – Simon Haykin, Wiley, 1988.
4. Digital communication fundamentals and applications - Sklar, 2nd edition, Prentice Hall,2001.
5. Electronics communication systems – Fundamentals to advanced: wayneTomasi, Pearson Education, 5th edition, 2009.
6. Wireless communications and networking – Vijay K Garg, Elseiver, 2007.

M.Sc-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)
SCT - 3.2: Biomedical Instrumentation
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

Course Objective:

● To introduce an fundamentals of medical instrumentation

● To explore the human body parameter measurements setups

● To make the students understand the basic concepts of medical imaging systems

● To give basic ideas about how electrical safety is essential during use of biomedical appliances

Learning Outcome:

Student should able to

- Understand the physiology of biomedical system
- Measure biomedical and physiological information
- Discuss the application of Electronics in diagnostics and therapeutic area

UNIT 1 **(15)**

MEDICAL INSTRUMENTATION BASICS: Generalized Systems, Constraints. Classification of Biomedical Instruments, Bio-statistics, Regulation of Medical Devices. Overview of Fiber Optic Sensors, Radiation Sensors, Smart Sensors, Electro Chemical Sensors.

BIOELECTRIC SIGNALS AND ELECTRODES: Electrode-Electrolyte Interface, Polarizable and Nonpolarizable Electrodes, Electrode Model, Recording Electrodes, Internal Electrodes, Micro Electrodes.

UNIT 2 **(15)**

MEASUREMENT SYSTEMS: Patient Monitoring Systems, Measurement of Blood Pressure, Heart Rate, Pulse Rate, Temperature, Heart Sounds, Blood Flow and Volume, Respiratory Systems, Measurements, Cardiac Output Measurement, Blood pH, pO2 Measurement, Oximeters, Audiometers, Spectrophotometers.

UNIT 3 **(15)**

MEDICAL IMAGING SYSTEMS: Information content of an Image, Radiography, Computed Radiography, Computed Tomography, Magnetic Resonance Imaging, Nuclear Medicine, Single Photon Emission Computed Tomography, Positron Emission Tomography, Ultrasonagraphy.

UNIT 4 **(15)**

THERAPEUTIC AND PROSTHETIC DEVICES: Cardiac Pacemakers, Defibrillators, Hemodialysis, Lithotripsy, Ventilators, Incubators, Drug Delivery devices, Artificial Heart Valves, Heart Lung Machine, Applications of Laser. **ELECTRICAL SAFETY**: Physiological Effects of Electricity, Important susceptibility parameters, Distribution of Electric Power. Macroshock Hazards, Microshock Hazards, Electrical safety codes and Standards, Basic Approaches to Protection against shock, Equipment Design, Electrical Safety Analyzers, Testing.

References:

1. Medical Instrumentation application and Design - John G.Webster, Editor, John Wiley & Sons, Inc Noida. 3rd Edition, 2008
2. Handbook of Biomedical Instrumentation - R.S.Khandpur, Tata McGraw Hill, New Delhi, 2nd Edition, 2008
3. Introduction to Biomedical Equipment Technology- Joseph J. Carr and John M. Brown, Pearson Education, 4th Edition, 2008

M.Sc-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)
OET - 3.1: Communication & Digital Electronics
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

Course Objective:

- The primary aim is to acquaint the students with basic principles of introduction to communication.
- To study construction of modulation and demodulation techniques
- To study FDM, TDM, FDMA, TDMA, CDMA and OFMDA
- To study Boolean Algebra and Logic Gates

Learning Outcome:

After completing this course students shall be able to:

- Explain basic concepts & basic principles of communication
- Explain the operation & design of various electronic instruments like FDM, TDM, FDMA, TDMA, CDMA and OFMDA
- Understand Boolean Algebra and Logic Gates

UNIT 1 **(15)**

Introduction to communication, need for modulation, modulation and demodulation techniques AM, FM and PM (Qualitative Analysis only), Block diagram of AM and FM transmitter and Receiver (Qualitative analysis) Sampling theorem, channel capacity, PAM, PPM, PWM and PCM, Digital modulation technique ASK, PSK, QPSK (Qualitative Analysis only).

UNIT 2 **(15)**

Introductory Aspects of Multiplexing and Multiple Accesses: FDM, TDM, FDMA, TDMA, CDMA and OFMDA.

Satellite Communication: Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

UNIT 3 **(15)**

Evaluation of Communication: 1 st generation, 2nd generation, 3rd generation & 4th generation mobile communication, Basics of cellular communication (GSM, CDMA)- Cell architecture, Base stations, relay stations and principles of communication, Introduction to Bluetooth, Wi-Fi, Wi-Max and LTE network.

UNIT 4 **(15)**

Binary Systems: Introduction to Digital Systems, Number systems, binary number system, Decimal to binary & binary to decimal conversion, representation of binary using hexadecimal.

Boolean Algebra and Logic Gates: Basic definitions, operators of Boolean algebra, basic theorems and properties of Boolean algebra, basic gates -AND, OR, NOT, XOR, NAND, NOR - only truth table & gate representation, Boolean functions, canonical or standard forms,

REFERENCE BOOKS:

1. Floyd T L " Digital Fundamentals", 7th Edition. (Pearson Education Asia), 2002

2. M. Morris Mono, Digital Logic and Computer Design, 4 th Edition, Pearson, 2009

3. Simon Haykins, An Introduction to Analog and Digital Communication, Wiley Student Edition, 2008.

4. B. P. Lathi, Modern digital and analog Communication systems, 3rd Edition 2005 Oxford University press.

5. Harold P.E, Stern Samy and AMahmond, Communication Systems, Pearson Edition, 2004

6. Dennis Roody and John Coolen, Electronic Communication, 4th Edition, 2008.

M.Sc-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)
OET - 3.2: Power Supplies
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

Course Objective:

- To impart the knowledge of automatic generation control and automatic voltage regulation
- To study various types of power supplies
- To develop understanding of heat sinks.

Learning Objectives

Students able to

- To understand the concepts of inductance
- To explain power supplies and its building blocks, design, characterization

Unit - 1 : Transformers (15)

Basics and design considerations: Transformers rated for 230 Volts and 208 volts primary, transformer voltage, current, and turns ratios, step-up and step-down voltage transformers, VA ratings for transformers, current transformers, dimmerstats, Transformer cores – frequency response, size, shapes, copper wire current ratings, Transformer winding techniques – for single output, multiple outputs, center tap, transformers for switching power supply.

Unit – 2: Constant Voltage (CV) Power supplies (15)

Constant Voltage (CV) Power supplies: Building blocks, Design, characterization. Zener regulator, emitter follower regulator, series regulator, shunt regulator, current limiting techniques, Switching mode regulator Constant Current (CC) and CV/CC Power supplies: Building blocks, Design, characterization. CC sources – using discrete transistor, monolithic transistors, controlled sources, Series regulator type CC supply, Guarded CC supply, Adjustable VL CC supply, Typical CV/CC supply.

Unit – 3 Power supplies using ICs **(15)**

Power supplies using ICs: General purpose regulators, precision regulators, fixed voltage regulators, Switch mode regulators.Protection techniques: Protection against transients, RFI suppression, current limiting, voltage limiting.

Unit – 4 Heat Sinks **(15)**

Heat Sinks: Effect of temperature on leakage current, current gain and power dissipation of active devices, thermal runaway, operation with and without heat silks, heat sink ratings, capabilities, practical considerations and mounting, heat sinks for ICs.

Text / Reference Books:

1. Simplified design of linear Power supplies: John D. Lenk, Butterworth-Heinemann
2. Simplified design of switching power supplies: John D. Lenk, Butterworth-Heinemann
3. Regulated power supplies Irving M Gottlieb, TAB books
4. Practical Design of Power Supplies: Ron Lenk, IEEE press +McGraw hill
5. Electric Power Transformer Engineering: James H. Harlow, CRC Press

M.Sc-II, SEME. IV, PHYSICS (APPLIED ELECTRONICS)
HCT -4.1: SEMICONDUCTOR DEVICES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

COURSE CODE: HCT 4.1 (60 lectures, 4 credits)

Course Objectives:

- To understand basic knowledge and description to the field of semiconductor theory, operation, designof devices and their Applications.
- To implement mini projects based on concept of electronics circuit concepts.
- To understand the details the various bias circuits of FET, MOSFET, BJT, CCD, SCR, LED, LASER etc.

Learning Outcomes:

After the completion of this course students should be able to:

- Students will come to know the fundamentals of the operation of the p-n junction in forward and reverse bias including knowledge of drift and diffusion currents, generation and recombination currents, contact potential, reverse bias capacitance and breakdown.
- Students will know basic operation of optical p-n junction devices including, FET, MOSFET, photo-detectors, solar cells, CCD, LEDs and LASER diodes.
- Also, the basic operation of the MOSFET including depletion, inversion, drain current, drain and gate voltages will be understood.

Unit I: MIS Structure and MOS FETs (15)

Schottky diode, MIS structures, basic equations in flat band conditions, MIS capacitances, current flow mechanisms in MS junction and MIS junction, depletion and enhancement type MOS FETS, capacitances in MOS FETs, quantitative analysis of I - V characteristics, thresholds in MOSFETS, charge trapping and flat band voltage, study of CMOS devices.

Unit II: Power Devices (15)

Power diodes, ratings, reverses recovery characteristics, fast recovery diodes, Power transistors,Switching characteristics, construction of SCR, two transistors analogy, I - V characteristics, gate trigger characteristics, turn on and turn - off times, losses, reverse recovery characteristics, SCR ratings, dv/dt and di/dt characteristics, thyrister types, construction and characteristics of DIACs and TRIACs, static induction thyristors, , light activatedthyristors, Gate turn off thyristors (GTO), MOS controlled thyristors, programmable Unijunction transistors, Silicon Unidirectional switch (SUS) , IGBT

Unit III: Charge Coupled and Transferred Electron (15)

Charge storage, surface potential under depletion, construction of basic two and three phase of CCD, mechanism of charge transfer, Oxide Charges, charge trapping and transfer efficiency, dark current, buried channel CCD, application of CCD, Transferred Electron Effect, NDR (Negative differential resistivity of voltage and current controlled devices), formation of gunn domains, uniform and accumulation layer, operation modes, transistors and quenched diodes, layers and modes of operation, LSA mode of operation, frequency responses and overall device performance of Gunn devices.

Unit IV: Optoelectronic and Advanced Solid State Devices (15)

Light emitting diodes, Performance of LEDs, emission spectra, visible and IR LEDs, semiconductor LASER: p-n junction lasers, heterojunction lasers, materials for semiconductor LASER, threshold current density, effect of temp. Quantum well hetero structures,

Detectors:photoconductors, photocurrent gain and detectivity, photodiodetypes : p-n junction, p-i-n, avalanche characteristics, quantum efficiency, response speed, noise and optical absorption coefficient, efficiency, Solar cells – current voltage characteristics

Reference Book/Text Book:

1. D.A. Roustan: Bipolar Semiconductor Devices.
2. Mauro Zambuto: Semiconductor Devices.
3. D. Nagchoudhari: Semiconductor Devices.
4. Karl Hess: Advanced theory of semiconductors devices.
5. S. M. Sze: Physics of Semiconductor Devices 2nd edition..
6. A Dir - Bar - Lev: Semiconductor and Electronic Devices.
7. M. H. Rashid: Power Electronics.
8. P. C. Sen: Power electronics
9. B. G. Streetman and S. Banergee : Solid state Electronic Devices

M.Sc-II, SEME. IV, PHYSICS (APPLIED ELECTRONICS)
HCT - 4.2: NUCLEAR AND PARTICLE PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

COURSE CODE: HCT 4.2 (60 lectures, 4 credits)

Course Objective

- One of the main objectives of the study of nuclear physics is the understanding of the 'Structure of Nuclei'.
- This includes all aspects of the motion of the nucleons, their paths in space, their momenta, the correlations between them, the energies binding them to each other.
- Understand most basic property of a nucleus is its binding energy.
- This brought about by the specific nuclear forces, counteracted partially by the interaction of different types of neutron and proton scattering.
- To understand nature of nuclear forces

Learning Outcome

- Student will get acquainted with external and internal properties of the atomic nucleus.
- Describe properties of deuteron and neutron proton forces, scattering at different energies.
- Classify and describe types of nuclear reactions as well properties of the resulting components.

Unit 1. Properties of Nucleus & Nuclear Forces (15)

Shape and Size, mass, spin and parity, masses and relative abundances, binding energy & nuclear stability, nuclear compositions, quantum properties of nucleon states, Radioactivity; Laws of radioactivity, radioactive dating, radioactive series, theory of alpha, beta & gamma decays and their properties. Nuclear forces: Properties of nuclear forces, two nucleon systems deuteron with potentials, n-p and p-p/n-n interactions at different energies, Yukawa's hypothesis, Meson theory of nuclear force.

Unit 2. Nuclear models: (15)

Fermi gas model, liquid drop model and Bethe-Weizsacker formula, their applications; shell model and shell structure , extreme single particle shell model with potentials – square well, harmonic oscillator, spin orbit interaction, Magic numbers, Predictions of the shell model; collective nuclear model;
superconductivity model (ideas only).

Unit 3. Nuclear reactions: (15)

Types of nuclear reactions, conservation laws, Nuclear reaction kinematics, nuclear scattering cross section determinations, compound nucleus disintegration, Breit Wigner dispersion formula (one level), direct reactions, nuclear transmutation reactions, nuclear fission and fusion,

Unit 4. Particle Physics & Cosmic rays: (15)

Broad classification of elementary particles and particle interactions in nature, conservation laws, symmetry classifications of elementary particles- Gell-Mann-Nishijima scheme,CPT conservation, Quark hypothesis & Quantum chromodynamics (ideas only); Cosmic rays: origin of cosmic rays, nature of primary cosmic rays and its energy distribution, its geomagnetic ,latitude effect, east-west asymmetry, origin of secondary rays, collision with electrons,. Particle accelerators and detectors: linear accelerators, cyclotron, synchrotron, colliding beam accelerators (LHC), gas-filled counters, scintillation detectors, semiconductor detectors.

Recommended Books:

1. Atomic and Nuclear Physics: Gopalakrishnan (MacMillan)
2. Concepts of Modern Physics: A.Beiser.
3. Concepts of Nuclear Physics: Bernard L Cohen.
4. Nuclear Physics: D C Tayal.
5. Subatomic Physics, Frauenfelder and Henley. (Prentice-Hall)

M.Sc-II, SEME. IV, PHYSICS (APPLIED ELECTRONICS)
HCT - 4.3: Microwave Devices & Circuits
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

COURSE CODE: HCT 4.3 (60 lectures, 4 credits)

Course Objective

The subject aims to provide the student with:

- An understanding of microwave waveguides, passive & active devices, tubes and network analysis.
- An ability to design microwave matching networks.
- An ability to perform microwave measurements.

Learning Outcome

The student after undergoing this course will be able to:

- Explain different types of waveguides and their respective modes of propagation.
- Analyze typical microwave networks using impedance, admittance, transmission and scattering matrix representations.
- Design microwave matching networks using L section, single and double stub and quarter wave transformer.
- Explain working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc.
- Describe and explain working of microwave tubes and solid state devices.
- Perform measurements on microwave devices and networks using power meter and TWT.

Unit I: F.M. Fields and Waves (10)

Microwave spectrum**,** Microwave applications, Electronic and Magnetic fields, Fields in conductors and Insulators, Maxwell's equations and boundary conditions, wave propagation in perfect Insulators, Wave polarization.

UnitII: Microwave Tubes (15)

Sources: Basic principles of two cavity Klystrons (Velocity modulation), Reflex Klystrons, TWT, Gunn effect, principle of operation.

Unit III: Microwave Transmission Lines (15)

Basic concepts of the open two-wire line, the coaxial line, strip type transmission lines, Rectangular and circular wave-guides, Theory of rectangular wave-guide transmission.

Unit IV: Coaxial and Stripline and Waveguide Components (20)

Coaxial and Stripline components: Terminations, matched loads, short and open circuits, standard mismatches, connectors and transitions, Dielectric bead supports, standard coaxial connectors, TEM to TEM transitions, Attenuators and phase shifters, coaxial and strip linge attenuators, coaxial and strip line shifters.

Waveguide components: Terminations, Matched loads, Standard mismatches, adjustable short circuits, Attenuators and phase shifters, Waveguide attenuators, waveguide phase shifters.

Reference Books:

1. Microwave Engineering: Peter Rizzi(PHI)
2. Microwave Devices and Circuits : S Y Liao (PHI)
3. Foundation for Microwave Engineering: R E Collin (MGH).
4. Microwave Integrated Circuits: K C Gupta and Amarjit Singh.

Topic for tutorials:

The problems /exercise/short questions answers/ circuit diagrams given in the Text and Reference Books will for Tutorial Course.

M.Sc-II, SEME. IV, PHYSICS (APPLIED ELECTRONICS)
SCT - 4.1: MICROCONTROLLER AND INTERFACING
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

Total hours: 60
Credits: 04

COURSE CODE: SCT 4.1 (60 lectures, 4 credits)

Course Objective

- To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
- To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
- To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

Learning Outcome

- Assess and solve basic binary math operations using the microprocessor and explain the microprocessor's and Microcontroller's internal architecture and its operation within the area of manufacturing and performance.
- Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.
- Compare accepted standards and guidelines to select appropriate Microprocessor (8085 & 8086) and Microcontroller to meet specified performance requirements.
- Analyze assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.
- Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.
- Evaluate assembly language programs and download the machine code that will provide solutions real- world control problems.

Unit I: 8051 Architecture and Hardware (15)

Introduction, 8051 microcontroller family, Pin configuration, Architecture, Program status word, Internal registers of 8051, Memory organization, Programming model of 8051, Special function registers (SFR's), Input /Output ports, Timers/counters, Interrupts and Serial Communication.

Unit II: Instruction Set and Assembly Language Programming of 8051 (15)
Instruction set: data transfer instructions, arithmetic instructions, logical instructions, program control instructions, stacks operations, data pointer instructions, addressing modes.
Assembly Language Programming: Port programming, timer /counter, interrupts, serial communication programming, induction to Keil integrated development environment (IDE)

Unit III: Embedded C programming for 8051 (15)
Embedded C general program structure, data types in embedded C, I/O programming, arithmetic and logical operations in embedded C, loops and decision programming (While, for, if else, and case structure), data serialization, data conversation in embedded C.

Unit IV: Interfacing and Programming with Hardware (With Assembly and C) (15)
LED, seven segment, switch, relay, DC Motor, Stepper motor, servo motor, LCD, ADC0804, LM35, DAC 0808 (square wave, triangular wave, saw tooth wave and Sin wave generation), serial communication and interrupts programming

Reference Books:

1. The 8051 microcontroller and embedded systems using assembly and C by Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay Person publication
2. The 8051 Microcontroller by Kenneth Ayala Cengage Learning publication
3. Programming And Customizing The 8051 Microcontroller Myke Predko , Publication Tab
4. 8051 Microcontrollers: an Applications Based Introduction by David Calcutt, Frederick Cowan, and G. Hassan Parchizadeh, publication Elsevier Science
5. 8051 Microcontroller-Internals,Instructions,Programming & Interfacing by Subrata Ghoshal Person publication.

M.Sc-II, SEME. IV, PHYSICS (APPLIED ELECTRONICS)
SCT - 4.2: MICROELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2021-2022)

COURSE CODE: SCT 4.2 (60 lectures, 4 credits)

Course Objective

The objective of the course is to provide students with an in-depth understanding of semiconductor device operation as well as the fabrication techniques used in their manufacture. The course will cover the basics of semiconductor physics, the important building blocks of the p-n junction and MOS capacitor, and the operation and fabrication of MOS and bipolar transistors. Students will also be introduced to the structure of the electronics industry and important developments that are driving future technologies

Learning Outcome

On completion of this course, the student will be able to:

- Use their knowledge of the theory of semiconductor physics to describe and demonstrate the principles of semiconductor building blocks such as pn junction and MOS structures.
- Derive the mathematical relationships that determine the operational characteristics of advanced bipolar and CMOS device architectures that make possible modern nanoscale integrated circuits;
- Use their understanding of the processing steps used in semiconductor microfabrication to produce integrated manufacturing procedures that will enable the production of advanced microelectronic products.
- Envisage novel technologies and contribute to the ongoing road mapping that will secure the future of the global microelectronics industry.

Unit I: Single crystalline Silicon and crystal structure (15)

(111) and (100) planes, Characteristics of substrates: physical (dimensional), electrical, dielectric, mechanical, Wafer cleaning process and wet chemical etching techniques, Environment for VLSI technology: clean room and safety requirements.

Epitaxial Process: Epitaxial Growth: VPE, LPE and MBE techniques, Mechanism, Chemistry and growth kinetics, evaluation of grown layer.

Unit II: Oxidationand Impurity Incorporation (15)

Oxide growth: dry, wet, rapid thermal oxidation; Deal Grove model of thermal oxidation, plasma oxidation,orientation dependence of oxidation rate, electronic properties of oxide layer, masking characteristics, oxide characteristics.

Impurity Incorporation:Interstitial and substitutional diffusions, diffusivity, laws governing diffusion, constant source and instantaneous source diffusion, Solid Source, liquid source and gas source Boron and Phosphorus diffusion systems, Ion implantation, annealing; Characterization of impurity profiles, buried layers

Unit III: Lithographic and Deposition Techniques (15)

Lithography: Types, Optical lithography –contact, proximity and projection printing, masks, resists: positive and negative, photo - resist pattering, characteristics of a good photo - resist, Mask generation using co-ordinaton graph and electron beam lithography.

Deposition Techniques for polysilicon and metals

Chemical Vapour deposition techniques: CVD technique for deposition of polysilicon, silicon dioxide and silicon nitride films; Metallisation techniques: Resistive evaporation and sputtering techniques. (D.C. and magnetron), Failure mechanisms in metal interconnects; multilevel metallisation schemes.

Unit IV: Device fabrication, Assembling and Packaging (15)

Masking Sequence and Process flow for pnp and npn devices , p-MOS and n-MOS, Die separation, bonding and attachments, encapsulation, package sealing, flat package, PGA (Printed Grid Array), BGA (Ball Grid Array)

Reference Books:

1. S.M.Sze (Ed), "VLSI Technology", 2nd Edition, McGraw Hill, 1988.
2. Streetman," VLSI Technology". Prentice Hall, 1990
3. C.Y. Chang and S.M. Sze (Ed), "VLSI Technology", McGraw Hill Companies Inc., 1996.
4. S.K.Gandhi, "VLSI fabrication Principles", John Wiley Inc., New York, 1983.
5. Sorab K. Gandhi, "The Theory and Practice of Microelectronics", John Wiley & Sons
6. A.S Grove, "Physics and Technology of semiconductor devices", John Wiley & Sons,
7. Integrated Ckts: Design principles and Fabrication: Warner.

Topics for Tutorials/Seminars: The problem/ exercise / short questions answers/ block diagrams given in the reference books will from the Tutorial Course.

M.Sc, PHYSICS (APPLIED ELECTRONICS)
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Practical List

HCT 3.1/3.2

1. Digital Multiplexer Demultiplexer.
2. Assembly Language Programming on 8086 µp –I & II
3. Microcontroller – I Port Programming -I
4. Microcontroller – II Port Programming -II
5. Study of Speed, Thermocouple &Thermister.
6. RF Tuned Amplifier.
7. Up / Down Counter
8. Shift Register.
9. Study characteristic of the reflex klystron tube.
10. VSWR measurement.
11. Microcontroller –III-DC motor interface with µc-8051.
12. Microcontroller – IV-Servo motor interface with µc-8051.
13. Microcontroller – V-Study the serial communication of µc-8051..
14. Microcontroller – VI- Stepper motor interface with µc-8051.
15. Microcontroller – VII- Relay interface with µc-8051.
16. Microcontroller – VII- ADC interface with µc-8051.
17. Op-Amp application (Design of differentiator and integrator for sine wave at 1 KHz)
18. Study of Attenuator (Fixed and Variable type).
19. Study of Magic Tee.
20. Study of Directional coupler characteristics.

SCT 3.1/3.2

1. Active Filter (High Pass)
2. Astable and MonostableMultivibrator using IC-741.
3. Study of digital to analog conversion (DAC) using Op.Amp (IC-741).
4. Study of Amplitude modulation and demodulation.
5. Study of Frequency modulation and demodulation.
6. Wave - form generator (Square and Triangular).
7. Inverting & Non-inverting Adder for two inputs.
8. Op-Amp integrator & Differentiator.
9. Op-Amp instrumentation amplifier with IC 324.
10. VCO as a triangular wave generator.

OEP 3.1/3.2

1. Voltage Source.
2. Amplitude shift keying (ASK) modulation & demodulation.
3. Frequency shift keying (FSK) modulation & demodulation.
4. Phase Shift Keying (PSK) Modulation and Demodulation.
5. De-Morgan’s theorem
6. DTL gates