School of Physical Sciences
Solapur University, Solapur
Choice Based Credit System (CBCS)

(w. e. f. June 2016-2017)

M.Sc- Physics (Applied Electronics)

Semester- III

HCT - 3.1 Semiconductor Devices (C)	- 70+30=100
HCT - 3.2 Atomic, Molecular and Nuclear Physics (C)	- 70+30=100
SCT - 3.1 Communication Systems	- 70+30=100
SCT - 3.2 Instrumentation	- 70+30=100
Practical - V	- 70+30=100
Project - I	- 70+30=100

Semester IV

HCT - 4.1 Microelectronics (C)	- 70+30=100
HCT - 4.2 Microwave Devices & Circuits	- 70+30=100
SCT - 4.1 Fiber Optic Communications	- 70+30=100
SCT - 4.2 Microprocessors & Interfacing	- 70+30=100
Practical - VI	- 70+30=100
Project - II	- 70+30=100

The practical's examination at Sem.III & Sem. IV shall be of 2 laboratory practical's of 35 marks each & 1 project presentation. Each practical & project presentation shall carry 70 Marks.

(C) Indicates common courses of the school.

30 marks are for internal evaluation.

M.SC-II, SEME. III, PHYSICS (APPLIED ELECTRONICS)

HCT - 3.1: SEMICONDUCTOR DEVICES (C)

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Unit I : MIS Structure and MOS FETs (12)

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 (12)

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 activated thyristors, Gate turn off thyristors (GTO), MOS controlled thyristors, programmable Unijunction transistors, Silicon Unidirectional switch (SUS) , IGBT

Unit III: Charge Coupled and Transferred Electron Devices (12)

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, photodiode types : 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

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HCT - 3.2 : ATOMIC, MOLECULAR AND NUCLEAR PHYSICS (C)

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(w. e. f. June 2016-2017)

Unit I: Atomic structure and Atomic Spectra (10)

Quantum states of an electron, Quantum numbers, spectroscopic terms and selection rules, Pauli's Exclusion principle, Electron spin, Vector atom model, Spin-orbit coupling (LS and JJ coupling), fine structure, Hund's rule etc. Features of one electron and two electron spectra, hyperfine structure, Lande splitting factor (g), Zeeman effect (Normal and Anomalous).

Unit II: Molecular Spectra (10)

Molecular energy states and associated spectra, Types of molecular spectra. Pure rotational; spectra, Diatomic molecule as a rigid rotator, Diatomic molecule as a non-rigid rotator, its Energy levels, Spectra, Rotation spectra of polyatomic molecules, Linear, Spherical top, Symmetric top, Asymmetric molecules, Vibrating diatomic molecule as a Harmonic and Anharmonic oscillator, Vibration-Rotation Spectra, molecule as vibrating rotator, Born-Oppenheimer approximation, Electronic states of diatomic molecules, Franck-Condon principle.

Unit III: Nuclear Forces and Nuclear Models (16)

Nuclear Forces:

Introduction, Nature of nuclear force, Deuteron (Properties, non-excited and excited states), elements of deuteron problem, Neutron-Proton (n-p) scattering at low energies, Theory of n-p scattering, proton-proton (p-p) scattering at low energies; its theory, Low energy n-n scattering, Charge Independence and charge symmetry of nuclear forces. Similarities between n-n and p-p forces, Non-central forces, its properties, Ground state of deuteron, Magnetic moment, Electric Quadrupole moment, Saturation of Nuclear forces, High energy n-p and p-p scattering.

Nuclear Models:

Constitution of the nucleus; neutron-proton hypothesis, Nature of nuclear force, stable nuclides, Liquid drop model: Semi-empirical mass formula, applications of semi-empirical mass formula, Limitations of liquid drop model, Nuclear shell model: Shell model and it's evidence, Limitations of shell theory, Fermi gas model, Extreme Single Particle model, Individual Particle model, Superconductivity model.

Unit IV: Nuclear Reactions (12)

Types of Nuclear Reactions, Conservation laws, Nuclear reaction kinematics, Nuclear Transmutations, Charged particle reaction spectroscopy, Neutron spectroscopy, Nuclear reactions-Q values and kinematics of nuclear cross-sections, Analysis of cross section classical and partial analysis, its energy and angular dependence, Thick Target yield,

Requirements for a reaction, Reaction mechanism, General features of cross-section, Inverse reaction, Compound Nucleus – introduction, its reactions and disintegration, Different stages of a Nuclear Reactions, Statistical Theory of Nuclear Reactions, Direct reactions, stripping reactions and shell model, Giant Resonance, Heavy ion reactions, Nuclear shock waves.

References:

1. Introduction to atomic spectra, H. E.White, Mc-Graw hill, International Edition.1962.
2. Molecular structure and spectroscopy 2nd Edi., G. Aruldhas, PHI learning Pvt. Ltd. NewDelhi.
3. Fundamentals of Molecular Spectroscopy, Colin Banwell, McGraw-Hill Publishing Company.
4. Introduction to Atomic and nuclear Physics, Harvey E. White, Van Nostrand Reinhold Company, 1964.
5. Nuclear Physics, D.C. Tayal, Himmalaya Publishing House, 5th Edi. 2008.
6. Introductory nuclear Physics, Kenneth S. Krane, John Wiley and Sons, 1988.
7. Nuclear Physics, Irving Kaplan, Addison-wesley publishing company, Inc,1962.
8. Concepts of Nuclear Physics, Bernard L Cohen, Tata McGraw-Hill publishing company limited, 1971.
9. Nuclear Physics, S. N. Ghoshal, S. Chand and company limited, 1994.

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SCT - 3.1: COMMUNICATION SYSTEMS

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Unit 1: A.M. Transmitters and Receivers (12)

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 (12)

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 (12)

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 (12)

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: wayne Tomasi, Pearson Education, 5th edition, 2009.
6. Wireless communications and networking – Vijay K Garg, Elseiver, 2007.

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SCT - 3.2: INSTRUMENTATION

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Unit I: Transducers (12)

Transducers classification Resistance, Capacitance, Inductance, Piezoelectric, Thermoelectric, Hall effect, Tachogenerator, Optical and Digital transducers, Measurements of displacement, Velocity, Acceleration, position, Force, pressure, flow, level, Torque, Strain, Speed and Sound, flow humidity, PH, position, Piezoelectric devices, micromechanical devices and smart sensors.

Unit II: Instrumentation Electronics (12)

Instrumentation Amplifiers, basic characteristics, D.C. Amplifiers, Isolation amplifiers, feedback transducers system, feedback fundamentals, Inverse transducers, temperature balance system,

Phase sensitive detection, Absolute value circuit, peak detector, sample and hold circuits, RMS converter, Logarithm (Amplifier, Frequency to Voltage and Voltage to Frequency Converter,

Unit III: Measuring Instruments (14)

True RMS measurement and DMM, R, L, C, Q measurement technique, active passive component testing, Automatic Test Equipment. Function generator, Sine, square, triangular, ramp wave generator, pulse generator, sine wave synthesis, arbitrary waveform generator. Oscilloscope: Dual Trace Oscilloscope, sweep modes, active, passive probes, delay line, Digital Storage Oscilloscope and its features like roll, refresh, sampling rate, application of the same in instrumentation and measurement, sampling oscilloscope. Wave analyzer, Distortion analyzer, spectrum analyzers.

Unit IV: Signal Processing Circuits (10)

ADC and DAC techniques, types, and their specifications, V to F converter, Sample and hold, analog multiplexer, data loggers. Digital Instrumentation: Universal counter and its mode – totalizing frequency, period, time. interval, ratio, measurement errors, application of counters for, frequency meter, capacitance, meter and timers, automation digital instruments. Virtual Instrumentation and its applications,

Reference Books:

1. Transducer Theory and Application: John A Alloca, Allen Stuart (Reston Publishing Company Inc.)
2. Transducer and Display Devices: B. S. Sonde.
3. Integrated Electronics: K. R. Botkar.
4. W. D. Cooper & A. D. Helfrick, ‘Electronic Instrumentation And Measurement Techniques’, PH I, 4th e/d, 1987
5. Kalsi H. S., ‘Electronic Instrumentation’, TMH, 2nd e/d, 2004

M.SC-II, SEME. IV, PHYSICS (APPLIED ELECTRONICS)

HCT - 4.1: MICROELECTRONICS (C)

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Unit I: Single crystalline Silicon and crystal structure (12)

(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: Oxidation and Impurity Incorporation (12)

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 (12)

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 (12)

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.

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HCT - 4.2 : Microwave Devices & Circuits

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Unit I: F.M. Fields and Waves **(08)**

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.

Unit II: Microwave Tubes **(10)**

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

Unit III: Microwave Transmission Lines **(12)**

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 **(18)**

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.

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SCT - 4.1: Fiber Optic Communication

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Unit – 1 **(12)**

Introduction and Transmission characteristics of optical fibers: The general optical communication system, Advantages and disadvantages, Ray theory of transmission, Mode theory, Types of optical Fibers

Transmission characteristics of optical fibers: Attenuation, Material absorption, losses in fibers, Linear and Nonlinear scattering losses, fiber bend loss, Mid-infrared and Far-Infrared transmission. Dispersion: Intermodal and Intramodal dispersion, Dispersion modified Single mode fibers.

Unit – 2 **(10)**

Optical fibers and cables, Joints and Couplers: Preparation of optical fibers, Liquid phase and vapour phase deposition techniques, Fluoride glass fibers. Cables: Fiber strength, durability and stability of fiber transmission characteristics, cable design

Optical Fiber Joints and Couplers: Fibers alignment and joint loss. Fiber splices, connectors, Fiber couplers.

Unit – 3 **(15)**

Optical sources and Optical detectors: Optical sources: LASERS basic concept, optical emission from semiconductors. Semiconductor Injection Laser, Injection laser structures and characteristics, Laser fiber coupling, Non-semiconductor Lasers, Laser Modulation.LED) LED power and efficiency, LED structures, characteristic and Modulation techniques.

Optical detectors: Introduction, device, types, optical detection principals, absorption, quantum efficiency Responsivity, Long wavelength Cutoff. Semiconductor photo diodes with and without internal gain. Mid-infrared and photoconductive detectors, PN, PIN, Avalanche Photo diodes, Phototransistors.

Unit – 4 **(11)**

Optical fiber Measurements, Receiver performance considerations and Applications: Optical fiber Measurements: Attenuation, Dispersion, Refractive index profile, cut-off wavelength, Numerical aperture, fiber diameter and field measurements. Receiver performance considerations: Noise, Receiver noise, Receiver structures, FET preamplifiers, High performance amplifiers. Applications: Public Network, Military, Civil, Consumer, Industrial and Computer applications.

Reference:

1. Optical fiber communications – principles and practice. John. M. Senior
2. Optical communications By David Gover
3. Optical communications By KEISER

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SCT - 4.2: MICROPROCESSORS AND INTERFACING

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Unit I: Basic Concept of Interfacing (15)

Input/output data transfer techniques: Input ports, Output ports, I/O Interfacing- I/O mapped I/O and memory mapped I/O.

Basic concept of memory interfacing with 8085: Address map, Address decoding, Examples of ROM (27XX) and RAM (62XX) interfacing with 8085 microprocessor.

Unit II: Interrupts and Programmable Interrupt Controller Interface (10)

Introduction, Polling and Interrupts, Classification of Interrupts, Interrupts in 8085, Hardware interrupts in 8085, Masking / Unmasking of Interrupts, Interrupts Acknowledgement , 8259A Interrupt Controllers, Features of 8259, Block diagram of 8259A, Programming the 8259 A , 8259A Interfacing with 8085.

Unit III: Programmable I/O Devices (18)

Programmable Peripherals Interface 8255

Introduction, Features of 8255 A, Signal of 8255, Block Diagram, Data Bus Buffer, Control Logic, Group A and Group B Controls, Operating Modes, Control Word Formats, 8255A Interfacing with 8085.

Programmable Interval Timer 8253

Necessity and Introduction, Features, Block Diagram, Operation Description, Mode Definition, Interfacing of 8253 with 8085.

Keyboard and Display Interface 8279

Introduction, Keyboard Interfacing, Display Interfacing, IC 8279, Features, Signals, Block Diagram, Operating Modes, 8279 Commands. Interfacing with 8085.

Unit IV: A/D and D/A Converters and Interfacing (10)

Introduction, Digital to Analog Converter, DAC Characteristics, Basic Conversion Techniques, Binary Weighted Resistor D/A Converter, R/2R, Ladder D/A Converter, IC 1408 DAC, Interfacing DAC with 8085.

Analog to Digital Converter, ADC Characteristics, Basic Conversion Techniques, Successive Approximation ADC, Flash ADC, IC 0809 ADC, Interfacing with 8085.

Reference Book:

1) 8085A /8080 Microprocessors: Architecture, Programming and Applications, - Ramesh Gaonkar
2) Microprocessor Interfacing Techniques - Zaka Lasen - BPB Publisher.
3) 8 bit & 16 bit Microprocessors - B. Ram, S. Chand Publisher.
4) 8085 / 8080 A Microprocessor: Architecture, Programming & Interfacing by Raffic Zeeman.
5) 8085/8086 Architecture, Programming & Interfacing by Mazidi.