Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: Condensed Matter Physics

Name of the Course: M.Sc. I (Sem.– I & II)

(Syllabus to be implemented from w.e.f. June 2019)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

SCHOOL OF PHYSICAL SCIENCES,
M.Sc. I – Physics (Condensed Matter Physics)
Choice Based Credit System
w.e.f June 2019-20

Semester	Code	Title of the Paper	Semester exam			L	T	P	Credits
First		**Hard core**	**Theory**	**IA**	**Total**				
CMP	**HCT1.1**	Mathematical Techniques	70	30	100	4		-	4
	HCT1.2	Condensed Matter Physics	70	30	100	4		-	4
	HCT1.3	Analog & Digital Electronics	70	30	100	4		-	4
		Soft Core (Any one)							
	SCT1.1	Classical Mechanics	70	30	100	4		-	4
	SCT1.2	Elements of Materials Science	70	30	100	4		-	
		Tutorial			25		1		1
		Practical							
	HCP1.1	Practical HCP 1.1	35	15	50	-	-	2	6
	HCP1.2	Practical HCP 1.2	35	15	50	-	-	2	
	HCP1.3	Practical HCP 1.3	35	15	50	-	-	2	
		Soft core (Any one)							
	SCP1.1	Practical SCP1.1	35	15	50	-	-	2	2
	SCP1.2	Practical SCP1.2	35	15	50	-	-	2	
		Total for first semester	**420**	**180**	**625**				**25**
Second		**Hard core**							
CMP	**HCT2.1**	Quantum Mechanics	70	30	100	4		-	4
	HCT2.2	Electrodynamics	70	30	100	4		-	4
		Soft core (Any one)							
	SCT2.1	Analytical Techniques	70	30	100	4		-	4
	SCT2.2	Statistical Mechanics	70	30	100	4		-	
		Open elective (Any one)							
	OET2.1	Nanomaterials: Synthesis, Properties And Applications	70	30	100	4		-	4
	OET2.2	Conventional & Non conventional Energy	70	30	100	4		-	
	HCT/P2.3	Communicate in English Confidently	55	20	75	3	-	1	3
		Tutorial			25		1	-	1
		Practical							
	HCP 2.1	Practical HCP 2.1	35	15	50	-	-	2	4

	HCP2.2	Practical HCP 2.2	35	15	50	-	-	2	
		Soft core (Any one)							
	SCP2.1	Practical SCP2.1	35	15	50	-	-	2	2
	SCP2.2	Practical SCP2.2	35	15	50	-	-	2	
		Open elective (Any one)							
	OEP2.1	Practical OEP2.1	35	15	50	-	-	2	2
	OEP2.2	Practical OEP2.2	35	15	50	-	-	2	
		Total for second semester	**420**	**180**	**625**				**25**

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

M.SC-I, SEME. I, PHYSICS (Condensed Matter Physics)

HCT - 1.1: MATHEMATICAL TECHNIQUES

Choice Based Credit System (CBCS)

(w. e. f. June 2019-2020)

Unit I: Calculus of Residues (15)

COMPLEX VARIABLE AND REPRESENTATIONS: Algebraic Operations, Argand Diagram: Vector Representation, Complex Conjugate, Euler's Formula, De Moiver's Theorem, The n^{th} Root or Power of a complex number.

ANALYTICAL FUNCTIONS OF A COMPLEX VARIABLE : The Derivative of f(Z) and Analyticity, Harmonic Functions, Contour Integrals, Cauchy's Integral Theorem, Cauchy's Integral Formula,

Zeros, Isolated Singular points, Evaluation of Residues, Cauchy's Residue theorem.

Unit II : Operator and Matrix Analysis (15)

Vector Space and its dimensionality, Vector Spaces and Matrices, Linear independence; Bases; Dimensionality, linear dependence, Inner product Hilbert space, linear operators.

Matrix operations, properties of matrices, Inverse, Orthogonal and unitary matrices; Independent elements of a matrix Diaglonization; Complete orthogonal sets of functions, special square matrices, Eigen values and eigenvectors; Eigen value problem.

Unit III: Ordinary Differential Equations (14)

First-Order homogeneous and non homogeneous equations with variable coefficients. The superposition principle, Second-order homogeneous equations with constant coefficient. Second-order non homogeneous equations with constant coefficients.

Unit IV: Fourier Series, Integral Transforms and Laplace transform (16)

Fourier Series: Fourier's theorem; Cosine, Sine and complex Fourier series, Applications to saw tooth and square waves and full wave rectifier. FS of arbitrary period; Half wave expansions; Partial sums Fourier integral and transforms; cosine since complex forms, Parsevals relation, Application to Gaussian distribution, box and exponential functions; FT of delta function.

Laplace transforms: Laplace transforms of common functions, First and second shifting theorems; inverse LT by partial fractions; LT of derivative and integral of a function.

Reference Books:

1. Introduction to Mathematical Physics by C. Harpcr, Prcnticc - Hall of India Ltd. N.Delhi 1993,(Chapters 2,4,6,9)

2. Mathematical Physics by A.G. Ghatak, I.C.Goyal and S.J.Chua, McMillan India Ltd. New Delhi 1995 (Chapters 4,7,9,10)

3. Matrices and Tensors for Physicists,by A W Joshi
4. Advanced Engineering Mathematics, by E Keryszig
5. Mathematical Method for Physicits and Engineers, by K F Reily, M P Hobson and S J Bence

6. Mathematics for Physicists by Mary L B
7. Mathematical Methods for Physics, by G Arfken

M.SC-I, SEME. I, PHYSICS (Condensed Matter Physics)

HCT - 1.2: CONDENSED MATTER PHYSICS

Choice Based Credit System (CBCS)

(w. e. f. June 2019-2020)

Unit I: Crystal Structure (15)

Basic Structures; symmetry properties, packing fractions, directions and position-orientation of planes in crystal, concept of reciprocal lattice, concept of brillouin zones, closed packed structure, and structures of some binary/ternary compounds. Elementary concepts of polycrystalline, nanocrystalline and amorphous materials. Elementary concepts of defects in solids. X-ray scattering from solids including Laue conditions and line intensities.

Unit II : Energy bands and Semiconductors (15)

Energy bands: Electron in periodic potential, Bloch function, solution of wave equation of electron in periodic potential, reduced, periodic and extended zone schemes. Construction of Fermi surfaces in brillouin zones for two - dimensional lattices, Introduction to methods for calculations of energy bands and their features. **Semiconductors:** Direct and indirect band gap semiconductors effective mass, intrinsic carrier concentration, impurity conductivity thermal ionization Revision on p-n junction and rectification, metal- semiconductor contacts, schotky barrier.

Unit III : Dielectric properties of Solids (15)

electronic, ionic, orientational, polarzabilities, static dielectric constant for gases, internal field in solids, dielectric constant of solids, dielectric relaxation in alternating fields, dielectric losses, complex dielectric constant.

Unit IV: Superconductivity (15)

Basic concepts, Meissner effect, heat capacity, energy gap, London equation, coherence length Josephson effect (flux quantization), type I and II superconductors, BCS theory, Introduction to high Tc Superconductors.

Reference Books:

1) Introduction to Solid State Physics 4 th Ed. C.Kittel,

2) Solid State Physics by A.J.Dekker

3) Solid State Physics by N.W.Ashoroff&N.D.Mermin

4) Solid State Physics S.O.Pillai

5) Solid state Physics by R.L.Singhal

M.SC-I, SEME. I, PHYSICS (Condensed Matter Physics)

HCT - 1.3: ANALOG & DIGITAL ELECTRONICS

Choice Based Credit System (CBCS)

(w. e. f. June 2019-2020)

Unit I: Operational Amplifiers (15)

Differential amplifier Circuit Configurations, Dual Input Balanced Output Differential amplifier , DC analysis, AC analysis, Inverting and Non Inverting Inputs, Constant Current Bias Circuit.

Block diagram of a typical Op-Amp, Open loop configuration, Inverting and Non-inverting amplifiers, Op-amp with negative feedback, Voltage Series Feed back, Effect of feed back on closed loop gain, Input resistance, Output resistance, Bandwidth and Output offset voltage, Voltage follower.

Practical Op-amp, Input Offset Voltage, Input bias current- input offset current, total output offset voltage, CMRR frequency response.

Unit II: Applications of Op amps (15)

DC and AC amplifier, Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Integrator and Differentiator.

Oscillator: Principles , Oscillator types, Frequency stability, Response , Phase Shift oscillator ,Wein Bridge Oscillator, LC Tunable Oscillator , Multivibrators, Monostable and Astable, Comparators, Square Wave and Triangle wave generators.

Voltage regulations: Fixed regulators, Adjustable voltage regulators, Switching regulators.

Unit III: Combinational & Sequential Logic Circuits (15)

Combinational logic:

The transistor as a switch, OR AND NOT gates- NOR And NAND gates Boolean algebra- Demorgans theorems- exclusive OR gate, Decoder/ Demultiplexer Date selector/ multiplexer - Encoder.

Sequential Logic:

Flip- Flops: RS Flip- Flop, JK Flip- Flop, JK master slave Flip-Flops Flip-Flop, D Flip- Flop, Shift registers Synchronous and Asynchronous counters.

Unit IV: Microprocessors (15)

Architecture of 8085, Signals and timing diagram of 8085, Demultiplexing Address and Data bus, Instruction Set, Addressing modes, Assembly Language Programming of 8085 (Sum of an array, Minimum and Maximum of an array, Multiplication & Division of 4 & 8 bit numbers) .

Reference Books:

1) OP Amp amplifiers by RamakantGaikwad
2) Integrated Circuits by K.R.Botkar
3) Modern Digital Electronics by R.P.Jain
4) Digital Principle and Application by Malvino&Leeach
5) Digital Fundamentals by Floyd
6)8085 Microprocessor by Ramesh Gaonkar

M.SC-I, SEME. I, PHYSICS (Condensed Matter Physics)
SCT - 1.1: CLASSICAL MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2019-2020)

Unit I : Mechanics of Particles and Rigid Bodies (15)

Mechanics of Particle and system of Particles using vector algebra and vector calculus, Conversion laws, work-energy theorem, open systems (with variable mass), Gyroscopic forces; dissipative systems, Jacobi integral, gauge invariance, integrals of motion; symmetries of space and time with conservation laws; invariance under Galilean transformations.

Unit II:Lagrangian Formulation and Motion Under Central Force (15)

Constrainsts, Generalised co-ordinates, D Alemaberts Principle, Lagranges equations of motion, Central Force, definition and characteristics, Reduction of Two-bod problem into equivalent One-body problem, General analysis of orbits, Keplers laws and equations, Artificial satellites, Rutherford Scattering.

Unit III: Variational Principle (15)

Introduction to Calculus of variation, Variational technique for many independent variables, Eulers Lagrange differential equation, Hamilton's principle, Deduction f Lagrange's equation of motion from Hamilton's principle.

Hamilton, Generalized momentum, Constant of motion, Hamilton's canonicl equations of motion, Deduction of canonical equations from Variations principle.

Applications of Hamilton's equations of motion, Principle of least action, Proof of principles of least action, Problems.

Unit IV: Canonical Transformations and Hamilton's - Jacobi Theory (15)

Canonical Transformations, Condition for Transformation to be Canonical, Illustration of Canonical Transformation, Poisson's Brackets, Properties of Poisson's Brackets, Hamilton's Canonical equations in terms of Poisson's Brackets.

Hamilton's - Jacobi Theory, Solution of harmonic oscillator problems by HJ Method, Problems.

Texts and Reference Books:

1. Classical Mechanics, By Gupta, Kumar and Sharma (Pragati Prakashan2000).
2. Introduction to Classical Mechanics, by R.G. Takwale and P S Puranik(Tata McGraw Hill 1999).
3. Classical Mechanics, by H Goldstein (Addison Wesley 1980).
4. Classical Mechanics, by N C Rana and P S Joag(Tata McGraw Hill 1991).
5. Mechanics, by A Sommerfeld (Academic Press 1952)

M.Sc-I, SEME. I, PHYSICS (Condensed Matter Physics)

SCT– 1.2 : ELEMENTS OF MATERIALS SCIENCE

Choice Based Credit System (CBCS)

(w. e. f. June 2019-2020)

Unit I: Introduction to materials: Classification, Properties and Requirements (15)

Introduction, Classification of Engineering Materials, Metals, Alloys, ceramics, Polymers and Semiconducting materials, Application of Engineering Materials.

Chemical Bonding: Introduction, Crystalline and Non-crystalline Solids, Classification of Bonds, Ionic Bond or Electrovalent Bond, Covalent Homopolar Bonds, Metallic Bonds, Molecular Bonds, Hydrogen Bond, van der Walls bond (Inter-molecular and Intra-molecular bonds).

Unit II: Optical Properties of Materials (15)

Introduction, Classification of Optical Materials, Interaction of light with matter, Absorption in Metals, Insulators and Semiconductors, Reflection, Refraction, Transmission and Scattering, Traps, Excitons, Colour Centers, Tauc and Lambert-Beer laws, Optical properties of Photonic material.

Luminescence and Photoconductivity Luminescence: Introduction, Principle, Classification of Luminescence, Photoluminescence, Cathodoluminescence, Electroluminescence, Thermoluminescence, Phosphorescence, Chemiluminescense, Applications.

Photoconductivity: Introduction, Photoconductivity, Characteristics of Photoconductivity Materials, Photodiodes, Photoresistor, Photodetectors, Photodetector Bias Circuit, Performance of Photodetector, Applications, Light emitting diodes (LED) and LASER's.

Unit III : Functional Materials (15)

Nanophase Materials: Introduction, Synthesis and techniques, Nucleation and growth mechanism, Characterization of Nanostructured Materials, Properties of Nanophase Materials, Applications.

Advanced Ceramics: Introduction, Classification of Ceramics, Structure of the Ceramics, Ceramic Processing, Properties of Ceramics, Applications.

Polymer Materials: Introduction, Polymerization Mechanism, Degree of Polymerization, Classification of Polymers, Structures of polymer and preparation methods, important properties and applications of commercial polymers-viz-polyethylene. Polyvinylchloride, Polystyrene, Nylon, Polyesters, Silicones, Composites, Composite material including nano-materials.

Unit IV: Phase diagrams & Diffusion in Solids (15)

Phase diagrams

Phase rule, Single component system, Binary phase diagram, Microstructure changes during cooling, Lever rule, Phase diagram rules, Applications of phase diagram.

Diffusion in solids

Ficks law of diffusion (1 st& 2 nd), Applications of second law of diffusion, Kirkendall effect, Atomic model of diffusion.

Reference Books:

1. Materials Science : V. Rajendran, A. Marikani, Tata MC Graw Hill
2. Materials Science & Engineering: Raghavan, Tata MC Graw Hill
3. Materials Science: Arumugam
4. Materials Science & Metallurgy : O. P. Khanna
5. Materials Science and Engineering: Callister S.

M.SC-I, SEME. II, PHYSICS (Condensed Matter Physics)
HCT - 2.1: QUANTUM MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2019-2020)

Unit I : Introductory Quantum Mechanics (16)

Waves and quanta: Wave and particle nature of radiation, Wave equation, Interpretation and properties of wave function; Heisenberg uncertainty principle. Operators, postulates of quantum mechanics, some important theorems, Eigen functions of the position operator and Dirac delta function. (AKC, pp 1-32)

Unit II: Wave Mechanics of simple systems (16)

One dimensional Box, Normalization and orthogonality, Discussion of the factors influencing colour. One dimensional harmonic oscillator, Normalization and Characteristics of eigen functions of harmonic oscillator, Hydrogen - like atoms, Total wave function of hydrogen- like atom, Prob. Density of 1s atomic orbital, shape of atomic orbital, physical interpretation of hydrogenic orbital, space quantization, electronic spin, Vibration and vibrational spectra of diatomic molecules. [AKC,pp:33-91]

Unit III : Many electron atoms (12)

Wave function of many electron systems, Helium atom, Many electron atoms, Hartree and HartreeFock self consistent field methods. [AKC, pp: 120-130)

Unit IV: Molecular Orbitals (16)

The Born- Oppenheimer approximation, Molecular orbital theory, Hydrogen molecule ion, Hydrogen Molecule - Molecular Orbital -Valance Band methods. [AKC, pp: 151-180]

Text Books:

1. Introductory Quantum Chemisty (3rd Ed^{n}), A. K. Chandra (Tata McGraw Hill).
2. Quantum Chemistry (4th Edition) - Ira N. Levine (Prentice Hall) of India Pvt. Ltd. New Delhi. 1995.
3. A textbook of Quantum Mechanics - P M Mathews, K Venkatesan. (Tata McGraw Hill).

M.SC-I, SEME. II, PHYSICS (Condensed Matter Physics)
HCT - 2.2:ELECTRODYNAMICS
Choice Based Credit System (CBCS)
(w. e. f. June 2019-2020)

Unit I: Multipole expansions and time varying fields (15)

Multipole expansions for a localized charge distribution in free space, linear quadrapole potential and field, static electric and magnetic fields in material media, boundary conditions, Time dependent fields, Faraday's law for stationary and moving media, Maxwell's displacement current, differential and integral forms of Maxwell's equations, Maxwell's equations for moving medium.

Unit II: Energy, force, momentum relations and electromagnetic wave equations (15)

Energy relations in quasi-stationary current systems, Magnetic interaction between two current loops, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy, Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth.

Unit III: Inhomogeneous wave equations (15)

Inhomogeneous wave equations, Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator, Hertz potential and its use in computation of radiation fields.

Unit IV: Radiation emission (15)

Radiation from an oscillating electric dipole, radiation from a half wave antenna, radiation from a group of moving charges, radiation damping, Thomson cross-section.

Text Book:

1. Introduction to Electrodynamics, (3rd Edition) by David J. Griffith Publication: Prentice-Hall of India, New Delhi.

Reference Books:

2. Introduction to Electrodynamics, by A.Z.Capri and P.V.PanatNarosa Publishing House.
3. Classical electricity & Magnetism, by panofsky and Phillips, Addison Wesley.
4. Foundations of Electromagnetic theory, by Reitz & Milford, World student series Edition.
5. Classical Electrodynamics, by J.D.Jackson, 3rd Edition John Wiley.
6. Electromagnetic theory and Electrodynamics, by Satya Prakash, KedarNath and Co.Meerut.
7. Electromagnetics by B.B.Laud, Willey Eastern.
8. Electrodynamics by Kumar Gupta and Singh.

M.SC-I, SEME. II, PHYSICS (Condensed Matter Physics)

SCT - 2.1: ANALYTICAL TECHNIQUES

Choice Based Credit System (CBCS)

(w. e. f. June 2019-2020)

Unit I: X-ray Diffraction techniques (18)

Review of basic crystal systems, powder diffraction method, instrumentation of X-ray diffractometer, sources of X-rays, detectors of X-rays, acquisition of raw data, data processing and refinement.

Determination of lattice parameters and crystal structure of cubic systems, structure factors, systematic absence of reflections, intensity calculations for cubic system, determination of particle size using X-ray diffractograms, basic concept for determination of lattice parameters for other crystal systems, use of soft-ware packages**.**

Unit II: Infra-red spectroscopy & Ultraviolet and visible spectrophotometry (18)

Infra-red spectroscopy (IR):

Introduction, Beer Lamberts law, Instrumentation, calculation of absorption maximum of dienes, dienons and polyenes, Qualitative and Quantitative applications.

Ultraviolet and visible Spectrophotometry (UV/Vis.):

Introduction, instrumentation, sampling technique, selection rule, types of bonds, absorption of common functional groups, Factors frequencies, applications.

Unit III: Fourier - Transform Infra Red Spectroscopy (FTIR) and Raman spectroscopy (12)

Basic principle, instrumentation configuration date interpretation and analysis, and special techniques such as Attenuated Total Reflection (ATR).

Unit IV: X-ray photoelectron spectroscopy (XPS) (10)

Basic principle, instrumentation configuration, data interpretation and analysis, chemical shift, quantification, and depth-profiling.

Reference Books:

1) Elements of X –ray diffraction: B.D. Cullity, Addison-Wiely Publisher

2) Encyclopedia of materials characterization: Surfaces, Interfaces, Thin Films C. Richard Brundle, Charles A. Evans, Jr. Shaun Wilson, BUTTERWORTH-HEINEMANN

3) Nanotechnology: Principles and Practices: S.B.Kulkarni, Capital Publishing Company

M.SC-I, SEME. II, PHYSICS (Condensed Matter Physics)
SCT - 2.2: STATISTICAL MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2019-2020)

Unit I: Foundations of statistical Mechanics and Classical Statistical Mechanics (15)

Thermodynamics, Laws of thermodynamics, Contact between statistics and thermodynamics, the classical ideal gas, entropy of mixing and Gibbs and paradox.

Classical statistical mechanics: Phase space, statistical ensembles, Liouville's theorem, Micro canonical ensemble-condition for equilibrium, canonical ensemble-partition function, energy fluctuations, Grand canonical ensemble-partition function, density and number fluctuations.

Unit II: Quantum Statistical Mechanics (15)

Phase space and quantum states, density matrix, Liouvilles theorem, ensembles, various statistics in quantum mechanics-Maxwell- Boltzmann, Fermi-Dirac and Bose-Einstein statistics, Ideal Bose gas, Fermi gas, Bose- Einstein condensation.

Unit III: Phase transitions and critical phenomena (15)

Phase transition, condition for phase equilibrium, first order phase transition, Clausius- Clayperon equation, second order phase transition, Critical indices, Properties of matter near the critical point. The law of corresponding states.

Unit IV: Fluctuations (15)

Thermodynamic fluctuations, spatial correlations in a fluid, Einstein - Smoluchowski theory of Brownian motion, Langevin theory of Brownian motion, The fluctuation-deposition theorem, The Fokker-Plank equation.

Reference Books:

1) Introduction to Statistical Mechanics by B.B.Laud
2) Statistical Mechanics by S.K.Sinha
3) Statistical Mechanics by I.D. Landau &F.M.Lifshitz

M.SC-I, SEME. II, PHYSICS (Condensed Matter Physics)

OET - 2.1: NANOMATERIALS: SYNTHESIS, PROPERTIES AND APPLICATIONS

Choice Based Credit System (CBCS)

(w. e. f. June 2019-2020)

Unit I: (15)

Graphene: Introduction of graphene, Graphite, Definition and structure of graphene, Types of graphene: stacking AA, BB, AB dispersion relation, Single layer, Bi-layer, Few layers

Properties of graphene; Optical: thickness dependency, optical conductivity, Electrical: Boltzmann equation, ambipolar conduction, diamagnetism, magnetoresistance and spin current, thermal conductivity, Surface phenomenon. Characterization of graphene: Transmission electron microscopy (TEM), Scanning tunneling microscopy (STM), Raman Spectroscopy, temperature dependent resistivity measurement.

Preparation of graphene: Chemical deposition (CVD) growth of graphene films, Chemically derived graphene, Hummer's method, Modified Hummer's method, Applications of graphene in the energy application: Li-ion batteries, Supercapacitors..

Unit II: (15)

Carbon Nanotubes: Introduction of Carbon Nanotube (CNT): Introduction and definition of CNT, Bonding of carbon atoms, SP3, SP2, Deformed SP2, Structure of Carbon Nanotubes, Chiral Vector, Armchair, Zig-Zag and Chiral tubes

Properties of Carbon Nanotubes: Electronic, Optical and

Optoelectronic, Mechanical, Chemical and Electrochemical, Opening of tubes

Synthesis Methods: High temperature method, Arc discharge, General technical features of the production process, Growth Mechanism, Chemical Vapor deposition (CVD) process, Vapor Liquid solid (VLS) model, Catalytic role, Methods of Purification, Methods of Functionalization (Chemical and Physical),

Applications of Carbon nanotube: Field emission, Li-ion battery, Supercapacitor, Sensors, Solar cells

Unit III: (15)

Nanotubes and nanowires: Fabrication of TiO_2 Nanotube Arrays by Electrochemical Anodization: Four Synthesis Generations, Material Properties of TiO_2 Nanotube Arrays: Structural, Elemental, Mechanical, Optical, and Electrical, Applications, Boron Nitride Nanotubes: Synthesis and Structure, One-Dimensional Semiconductor and Oxide Nanostructures, Inorganic nanowires

Unit IV: (15)

Polymer nanocomposites: Polymer composites: mechanical properties and composite fabrication. Introduction to polymer nanocomposites: Basic materials for polymer nanocomposite technology. Fabrication techniques: Solution intercalation, melt intercalation, roll milling, emulsion polymerization, in-situ polymerization and

high-shear mixing. Characterization of polymer nanocomposites, Properties of polymer nanocomposites: Thermoplastic nanocomposites, Thermoset Nanocomposites, Elastomer Nanocomposites. Applications of polymer nanocomposites in: high temperature, paint formulation, Automobiles, Aerospace, Injection Molded Products, Coatings, Adhesives, Fire-retardants, Packaging Materials, Microelectronic Packaging, Optical Integrated Circuits and Sensors.

Reference Books:

CNT and Graphene

1) Physics of Graphene, Editors: Aoki, Hideo, S. Dresselhaus, Mildred (Eds.)
2) Graphene: Carbon in Two Dimensions, by Mikhail I. Katsnelson
3) Graphene: Synthesis, Properties, and Phenomena, by C. N. R. Rao (Editor), Ajay K. Sood (Editor),
4) Carbon Nanotube and Graphene Device Physics, by H.-S. Philip Wong (Author), Deji Akinwande (Author)
5) Carbon Nanotube Electronics (Integrated Circuits and Systems) by Ali Javey (Editor), Jing Kong (Editor),
6) Physics and Chemistry of Graphene: Graphene to Nanographene, Toshiaki Enoki, Tsuneya Ando.

Nanotubes and nanowires

7) TiO2 Nanotube Arrays: Synthesis, Properties, and Applications by Craig A. Grimes and Gopal K. Mor, Springer Publisher
8) Nanotubes and Nanofibers; Advanced Materials Series, Series Editor: Yury Gogotsi, Drexel University, Philadelphia, Pennsylvania, USA, Nanotubes and Nanofibers by Yury Gogotsi

Polymer nanocomposites

9) Joseph H. Koo, Polymer Nanocomposites: Processing, Characterization, and Applications, McGraw-Hill, New Delhi, 2006.
10) Suprakas Sinha Ray and Mosto Bousmina, Polymer Nanocomposites and Their Applications, American Scientific Publishers, 2006

M.SC-I, SEME. II, PHYSICS (Condensed Matter Physics)
OET - 2.2: Conventional & Nonconventional Energy
Choice Based Credit System (CBCS)
(w. e. f. June 2019-2020)

Unit 1: Elementary electronics and electronic gadgets (Principles and Working) (15)

Different electronic components, semiconductors, different type of diodes, rectifiers, filters, pnp and npn transistors, amplifiers, oscillators. Catoderay Oscilloscope. Concept of modulation and demodulation. Transponder. Integrated circuits. Android phones, Bluetooth. Global Positioning System. Optical fibres Endoscope. Number systems. Decimal, Hexal and Octal systems.

Unit2: Energy Resources (15)

Conventional and Renewable energy resources. Coal, Oil and Natural gas. Oil exporting and importing countries. Oil pipe lines. World reserve estimates. Non conventional energy resources. Wind power and Solar power. Solar cell Ocean thermal energy conversion, energy from waves and tides. Biomass energy. Biogas plant. Ethanol as a fuel.

Concept of nucleus. Atomic number, mass number, isotopes and isobars. Natural and artificial isotopes. Radioactivity, carbon dating. Uses of isotopes. Enriched Uranium. Fission. Simple nuclear reactions. Chain reaction. Nuclear Reactors, moderators. Heavy water and Pressurized heavy water reactor. Breeder reactor. Weapons of mass destruction. Effects of atomic bombs explosions on Hiroshima and Nagasaki. Fusion reaction. Safety of nuclear reactors. Indian nuclear program.

Unit 3: Our Universe (15)

Units of stellar distances solar system earth's atmosphere. Variation of temperature and pressure with height. Different parts of atmosphere. Earth's magnetic field. Aurora Borealies. Characteristics of different planets. Asteroides. Comets, Meteorides. Stars. Binary and Multiple stars system Lunnosities of stars. Hertzsprung-Russell diagram. Evolution of stars. Neutron star, white dwarf and blackhole. Pulsars. Chandrashekhar limit. Galaxies and their classification. Hubble's law. Origin of universe (qualitative) Electromagnetic spectrum. Radio and Optical window. Reflecting and refracting telescopes. Different mountings. Radio telescopes. Few world famous telescopes. Mount Palomer, Jodrell bank and Keck telescopes. Few Indian telescopes: Kodaikanal, Kawalur, Leh, Gurushikar and Udaipur telescopes. Radio Telescope at Narayangaon.

Unit 4: Space Exploration (15)

Newtons laws of motion, law of gravitation and other kinematic equations. Free fall under gravity. Escape velocity. Keplers laws. Satellites natural and artificial. Different orbits. Near earth orbit, geosynchronyous orbit and polar orbit. Near earh orbit satellites. GTO satellites. Remote sensing satellites and their role in measurements of national resources and mapping. Rockets. Fuels used in rockets. Chandrayan, Mangalyan, Astrosat. Missiles and their classification. Indian Space program.

M.SC-, PHYSICS (APPLIED ELECTRONICS)
Choice Based Credit System (CBCS)
(w. e. f. June 2019-2020)

Practical List

HCP 1.1/1.2/1.3

1. Study of Filters.
2. Voltage Regulator.
3. Transistor Biasing.
4. C. E. Amplifier Design.
5. Op.Amp. Inverting and Non- inverting amplifiers
6. D.T. L. Gates.
7. C.E. with CC Amplifier.
8. AstableMultivibrator (IC 555)
9. Determination of Bandgap of Ge diode.
10. Temperature Transducer (Thermister).
11. Wein Bridge oscillator.
12. Negative Feedback Amplifiers.
13. DC Amplifiers.
14. FET Characteristics and Designing of Amplifier.
15. Op. Amp (Adder, Substractor, Integrator and Differentiator).
16. Crystal Structure (FCC- Type)
17. Verification of Demorgan's Theorem.
18. Op. Amp. Phase Shift Oscillator.
19. Temp. Variation of break down voltage of Zener Diode.
20. AstableMultivibrator (using 741 Op amps)
21. Op amp Phase Lead Circuit.
22. Op amp Phase Lag Circuit
23. Microprocessors (µp) - I (Logsun 8085 Kit)
24. Divide by 2, divide by 5 and divide by 10 counters using IC – 7490.

SCP 1.1/1.2

1. Characteristics of UJT .
2. Op. Amp. Parameters.
3. P - N Junction Capacitance.
4. LVDT.
5. Op. Amp. I to V and V to I converters.
6. Multiplication & Division using Microprocessor 8085.
7. Addition, Substractor, Multiplication using 89C51 microcontroller.
8. Logical operation using 89C51 microcontroller.
9. Microcontroller – III
10. Microcontroller – IV

HCP 2.1/2.2

1. Twin T Networks.
2. Butter worth low pass filter using IC- 741
3. Variable Duty cycle MV using Op. amp.(IC- 741)
4. Constant current source (Floating load).Using Opamp.
5. Constant current source (Grounded load). Using Opamp
6. Wein bridge oscillator
7. Op-Amp Op. Amp. Parameter (Slew rate, power band width, CMMR) .
8. Voltage regulator using IC 723.
9. Constant Voltage Source with Fold back Current Limit.
10. Constant Voltage Source (Precision Voltage Regulator) with
11. Constant Current Limit.
12. Study of Wein Bridge oscillator.

SCP 2.1/2.2

1. Microprocessor - VI (Ascending & Descending).
2. Microprocessor - VII (Decimal Addition & Odd & Even Parity).
3. Microcontroller - I Addition and subtraction of 8 bit and 16 bit numbers with and without carry.
4. Microcontroller – II Study of LED interfacing to 8051 microcontroller.
5. Microcontroller – III Study of ADC Interfacing to 8051 microcontroller.
6. Microcontroller – IV Study of DAC Interfacing to 8051 microcontroller.
7. Microcontroller – V -Determination of minimum & maximumnumbers.
8. Microcontroller – VI- LCD interfacing with µc -8051.
9. Microcontroller – VII-Seven segment interfacing with µc -8051.

OEP 2.1/2.2

1) Transister Parameters.
2) Op-Amp inverting and non-inverting amplifiers.
3) Monostablemultivibratorvsing IC555.
4) FET charaterishes.
5) Op-Amp Adder.
6) Op-Amp subtractor.
7) First order High pass filter.
8) First order Low pass filter.
9) Determination of optical gap.
10) Determination of optical absorption by materials & hence determination of type of transition.
11) Study of p.n. junction photo voltaic.
12) Characterization of a PV cell in dark & in light & hence determination of junction ideality factor.

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