PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

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

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: PHYSICS

(Applied Electronics/ Materials Science/Condensed Matter Physics)

Name of the Course: M.Sc. Part-I

(Syllabus to be implemented from w.e.f. June 2020)

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY

SCHOOL OF PHYSICAL SCIENCES

DEPARTMENT OF PHYSICS

Syllabus of M.Sc. Physics (Choice Based Credit System)

1) **Title of the course:** M.Sc. in Physics (Applied Electronics/Materials Science/Condensed Matter Physics)
2) **Duration of the course**: Two years.
3) **Pattern:** Choice Based Credit System (CBCS)
4) **Eligibility:** For M. Sc. in Physics following candidates are eligible.
   (i) B.Sc. with Physics at principal level.
5) **Intake Capacity:** 20

M. Sc. program in Physics consists of 100 credits. Credits of a course are specified against the title of the course.

A Four Semester M.Sc. Physics Course

Semester	No. of Papers/ Practicals / Seminar	Marks	Credits
Semester I			
• Theory Papers	04	400	16
• Practical Papers	04	200	08
• Seminar/Tutorial	01	25	01
Semester II			
• Theory Papers	04	400	16
• Practical Papers	04	200	08
• Seminar/ Tutorial	01	25	01
Semester III			
• Theory papers	04	400	16
• Practical Papers	04	200	08
• Seminar/ Tutorial	01	25	01
Semester IV			
• Theory papers	04	400	16
• Project	04	200	08
• Seminar/ Tutorial	01	25	01
Total marks and credits for M.Sc. Course		**2500**	**100**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
School of Physical Sciences
M.Sc. Physics Choice Based Credit System (CBCS)
Course Structure

M.Sc. Part-I Physics (Applied Electronics) w.e.f. 2020-21

M.Sc. PHYSICS SEMESTER-I								
Paper Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 1.1	Mathematical Physics	80	20	100	4	--	--	4
HCT 1.2	Solid State Physics	80	20	100	4	--	--	4
HCT 1.3	Analog and Digital Electronics	80	20	100	4	--	--	4
	Soft Core-Theory (Any one)							
SCT 1.1	Classical Mechanics	80	20	100	4	--	--	4
SCT 1.2	Fundamentals of Nanoelectronics							
	Practical							
HCP1.1	Practical-1: (Based on HCT 1.1)	40	10	50	--	2	--	2
HCP1.2	Practical-2: (Based on HCT 1.2)	40	10	50	--	2	--	2
HCP1.3	Practical-3: (Based on HCT 1.3)	40	10	50	--	2	--	2
SCP1.1/ 1.2	Practical-4: (Based on SCT 1.1/1.2)	40	10	50	--	2	--	2
	Seminar / Tutorial	---	25	25	--	--	1	1
Total for Semester-I		480	145	625	--	--	--	25
M.Sc. PHYSICS SEMESTER-II								
Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 2.1	Quantum Mechanics	80	20	100	4	--	--	4
HCT 2.2	Electrodynamics	80	20	100	4	--	--	4
	Soft Core Theory (Any One)							
SCT 2.1	Statistical Physics	80	20	100	4	--	--	4
SCT 2.2	Electronic Instrumentation							
	Open Elective Theory (Any one)							
OET 2.1	Fundamentals of Electronics	80	20	100	4	--	--	4
OET 2.2	Conventional & Non conventional Energy							
	Practical (Hard and Soft core)							
HCP 2.1	Practical-5: (based on HCT 2.1)	40	10	50	--	--	2	2
HCP 2.2	Practical-6: (based on HCT 2.2)	40	10	50	--	--	2	2

SCP 2.1/2.2	Practical-7: (based on SCT 2.1/2.2)	40	10	50	--	--	2	2
	Practical (Open Elective) Any One							
OEP 2.1	Practical -8: (based on OEP 2.1/2.2)	40	10	50	--	--	2	2
OEP 2.2	Practical-4: (based on OEP 2.2)							
	Seminar / Tutorial	---	25	25	--	1	--	1
Total for Semester-II		**480**	**145**	**625**	**--**	**--**	**--**	**25**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
School of Physical Sciences
M.Sc. Physics Choice Based Credit System (CBCS)
Course Structure

M.Sc. Part-I Physics (Materials Science) w.e.f. 2020-21

M.Sc. PHYSICS SEMESTER-I								
Paper Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 1.1	Mathematical Physics	80	20	100	4	--	--	4
HCT 1.2	Solid State Physics	80	20	100	4	--	--	4
HCT 1.3	Analog and Digital Electronics	80	20	100	4	--	--	4
	Soft Core-Theory (Any one)							
SCT 1.1	Classical Mechanics	80	20	100	4	--	--	4
SCT 1.2	Elements of Materials Science							
	Practical							
HCP1.1	Practical-1: (Based on HCT 1.1)	40	10	50	--	2	--	2
HCP1.2	Practical-2: (Based on HCT 1.2)	40	10	50	--	2	--	2
HCP1.3	Practical-3: (Based on HCT 1.3)	40	10	50	--	2	--	2
SCP1.1/ 1.2	Practical-4: (Based on SCT 1.1/1.2)	40	10	50	--	2	--	2
	Seminar / Tutorial	---	25	25	--	--	1	1
	Total for Semester-I	**480**	**145**	**625**	**--**	**--**	**--**	**25**
M.Sc. PHYSICS SEMESTER-II								
Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 2.1	Quantum Mechanics	80	20	100	4	--	--	4
HCT 2.2	Electrodynamics	80	20	100	4	--	--	4
	Soft Core Theory (Any One)							
SCT 2.1	Statistical Physics	80	20	100	4	--	--	4
SCT 2.2	Analytical Techniques							
	Open Elective Theory (Any one)							
OET 2.1	Fundamentals of Electronics	80	20	100	4	--	--	4
OET 2.2	Conventional & Non conventional Energy							
	Practical (Hard and Soft core)							
HCP 2.1	Practical-5: (based on HCT 2.1)	40	10	50	--	--	2	2
HCP 2.2	Practical-6: (based on HCT 2.2)	40	10	50	--	--	2	2
SCP 2.1/2.2	Practical-7: (based on SCT 2.1/2.2)	40	10	50	--	--	2	2

	Practical (Open Elective) Any One							
OEP 2.1	Practical -8: (based on OEP 2.1/2.2)	40	10	50	--	**--**	2	2
OEP 2.2	Practical-4: (based on OEP 2.2)							
	Seminar / Tutorial	---	25	25	--	1	**--**	1
Total for Semester-II		**480**	**145**	**625**	**--**	**--**	**--**	**25**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
School of Physical Sciences
M.Sc. Physics Choice Based Credit System (CBCS)
Course Structure

M.Sc. Part-I Physics (Condensed Matter Physics) w.e.f. 2020-21

M.Sc. PHYSICS SEMESTER-I								
Paper Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 1.1	Mathematical Physics	80	20	100	4	--	--	4
HCT 1.2	Solid State Physics	80	20	100	4	--	--	4
HCT 1.3	Analog and Digital Electronics	80	20	100	4	--	--	4
	Soft Core-Theory (Any one)							
SCT 1.1	Classical Mechanics	80	20	100	4	--	--	4
SCT 1.2	Energy Studies							
	Practical							
HCP1.1	Practical-1: (Based on HCT 1.1)	40	10	50	--	2	--	2
HCP1.2	Practical-2: (Based on HCT 1.2)	40	10	50	--	2	--	2
HCP1.3	Practical-3: (Based on HCT 1.3)	40	10	50	--	2	--	2
SCP1.1/ 1.2	Practical-4: (Based on SCT 1.1/1.2)	40	10	50	--	2	--	2
	Seminar / Tutorial	---	25	25	--	--	1	1
	Total for Semester-I	**480**	**145**	**625**	**--**	**--**	**--**	**25**
M.Sc. PHYSICS SEMESTER-II								
Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 2.1	Quantum Mechanics	80	20	100	4	--	--	4
HCT 2.2	Electrodynamics	80	20	100	4	--	--	4
	Soft Core Theory (Any One)							
SCT 2.1	Statistical Physics	80	20	100	4	--	--	4
SCT 2.2	Electronic Instrumentation							
	Open Elective Theory (Any one)							
OET 2.1	Fundamentals of Electronics	80	20	100	4	--	--	4
OET 2.2	Nuclear Techniques							
	Practical (Hard and Soft core)							
HCP 2.1	Practical-5: (based on HCT 2.1)	40	10	50	--	--	2	2
HCP 2.2	Practical-6: (based on HCT 2.2)	40	10	50	--	--	2	2
SCP 2.1/2.2	Practical-7: (based on SCT 2.1/2.2)	40	10	50	--	--	2	2

	Practical (Open Elective) Any One							
OEP 2.1	Practical -8: (based on OEP 2.1/2.2)	40	10	50	--	**--**	2	2
OEP 2.2	Practical-4: (based on OEP 2.2)							
	Seminar / Tutorial	---	25	25	--	1	**--**	1
Total for Semester-II		**480**	**145**	**625**	**--**	**--**	**--**	**25**

Evaluation Scheme:

Each theory paper will have 100 marks out of which 80 marks will be for Term End examination and 20 marks for Internal Assessment. The candidate has to appear for internal evaluation of 20 marks and external evaluation (University Examination) of 80 marks for each theory paper.

Each practical paper will have 50 marks out of which 40 marks will be for Term End examination and 10 marks for Internal Assessment. The candidate has to appear for internal evaluation of 10 marks and external evaluation (University Examination) of 40 marks for each practical paper.

Internal Evaluation:

- In case of theory papers internal examinations will be conducted by department / school.
- In case of practical papers, 5 marks shall be for day-to-day journal and 5 marks shall be for internal test, which will be conducted by the department / school.

External Evaluation (End of Term University Examination):

I) Nature of Theory question paper:

1) Each Theory paper is of 80 marks.
2) Each Theory paper will be of 3 hours.

II) Nature of Practical question paper: (End of Term Examination)

Sem-I and II: Practical examination (Performing of Experiments) will be conducted for 40 marks and is of two hours duration. VIVA will be for 10 marks.

_____xxxx_____

M.SC-I, SEME. I, PHYSICS (APPLIED ELECTRONICS)

HCT - 1.1: MATHEMATICAL PHYSICS

Choice Based Credit System (CBCS)

(w. e. f. June 2020-21)

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 (APPLIED ELECTRONICS)

HCT - 1.2: SOLID STATE PHYSICS

Choice Based Credit System (CBCS)

(w. e. f. June 2020-21)

Unit I: Crystal Structure (15)

Basic Structures, Bravais systems in 2D and 3D, Bonding in solids, Reciprocal Lattice, Diffraction by X-ray and structure factor, Point defects and dislocations, Specific Heat: Lattice vibration, Phonons, Einstein and Debye's theories.

Unit II: Energy bands and Semiconductors (20)

Energy bands:

Metal, Insulator and Semiconductor, Bloch theorem, Electron in periodic potential -1D, Tight and loose band approach, Brillion's Zones, Fermi surfaces.

Semiconductors:

Direct and indirect band gap semiconductors, Effective mass, Hall effect and thermoelectric power, Intrinsic and Extrinsic carrier concentration.

Unit III: Dielectrics (10)

Electronic, Ionic, Orientational polarizations, Clausius-Mossotti equation, Dipole theory of ferroelectricity, Internal field in solids, Classification of magnetic materials,

Unit IV: Superconductors (15)

Basic concept, Meissner effect, Types I and II, Thermal properties of superconductor, Thermodynamics of superconductors, London equation, Josephson tunneling and its theory, BCS theory.

Reference Books:

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

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

3) Solid State Physics S.O.Pillai (New age international limited Publications)

4) Solid State Physics by Saxena and Gupta(Pragati Editions)

5) Solid State Physics by Rita John (Mc Graw Hill)

M.SC-I, SEME. I, PHYSICS (APPLIED ELECTRONICS)

HCT - 1.3: ANALOG & DIGITAL ELECTRONICS

Choice Based Credit System (CBCS)

(w. e. f. June 2020-21)

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 Feedback, Effect of feedback 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,

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, Multiplexers and Demultiplexers

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 /Subtraction, Multiplication & Division of 4 & 8 bit numbers) .

Reference Books:

1) OP Amp amplifiers by Ramakant Gaikwad

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 (APPLIED ELECTRONICS)
SCT - 1.1: CLASSICAL MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (APPLIED ELECTRONICS)
SCT - 1.1: Fundamentals of Nanoelectronics
Choice Based Credit System (CBCS)
(w. e. f. June 2020-21)

Unit – 1 **(15)**

Region of nanostructures, scaling of devices in silicon technology, estimation of technology limits, Uncertainty principle, Experiments on duality, Schrodinger's equation and its applications to square well potential, square potential barrier (1D).

Unit – 2 **(15)**

Infinite array of potential wells, Barrier penetration, applications to tunnel diode, Josephson effect, Perturbation theory and its applications, Scattering. Binomial and related distributions, Phase space, Statistical ensembles, applications of classical statistical mechanics, Quantum statistics, Brownian motion, Random walk problem. Concept of Chemical potential, partition function and its applications in computing thermodynamic quantities.

Unit – 3 **(15)**Quantum

electronic devices, electrons in mesoscopic structures, short channel MOSFET, split-gate transistor, electron wave transistor, electron spin transistor, quantum cellular automata, Bioelectronics, molecular processor, DNA analyzer as biochip, Molecular electronics, Fullerenes, nanotubes, switches based on Fullerenes and nanotubes.

Unit – 4 **(15)**

Nanoelectronics with tunneling devices, resonant tunneling diode (RTD), three terminal RTDS, RTD based memory, basic logic gates and dynamic logic gates, Principle of single electron transistor, Coulomb blockade.

Text/ Reference Books:

1. Nanoelectronics and Nanosystems: K.Goser, P. Glosekotter, J. Dienstuhl, Springer (2005).
2. Quantum Mechanics: Schiff L.I. , “”
3. Fundamentals of Statistical Mechanics and Thermal Physics: Reif

M.SC-I, SEME. II, PHYSICS (APPLIED ELECTRONICS)
HCT - 2.1: QUANTUM MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-21)

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 (APPLIED ELECTRONICS)
HCT - 2.2: ELECTRODYNAMICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (APPLIED ELECTRONICS)
SCT - 2.1: STATISTICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Statistical Thermodynamics: (20)
Thermodynamic systems and equilibria, Laws of thermodynamics and their consequences, Nernst heat theorem, Microstates and microstates, Postulate of equal priori probability, Probability calculations, Thermodynamic potentials and Maxwell's relations, Chemical potential, phase equilibria, Black Body radiation and planks distribution, Phase equilibria, Free energy and its connection with thermodynamic quantities, entropy of mixing and Gibbs and paradox.

Unit II: Classical statistical mechanics: (15)
Statistical ensembles, Microcanonical ensemble- system in contact with heat revisor, Condition for thermal equilibrium, canonical ensemble – molecular ideal gas and grand canonical ensemble, Liouville's theorem, Ensembles, Maxwell Boltzmann distribution, classical ideal gas,

Unit III: Quantum Statistical Mechanics (15) Phase space (Diagram of an oscillator), Maxwell- Boltzmann statistics, Fermi-Dirac statistics and Bose- Einstein statistics, Liouville's theorem, Ideal Bose gas, Ideal Fermi gas- weekly and strongly degerate , Bose-Einstein condensation.

Unit IV: Phase transitions and critical phenomena (10) Phase transition, Triple Point, Condition for phase equilibrium, First order phase transition, Ehrenfests equations, Clausius- Clayperon equation, Second latent heat equation, Examples, Second order phase transition, Critical indices, The law of corresponding states.

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
4) Text Book of statistical mechanics. Suresh Chandra, CBS Publications
5) Elementary Statistical Mechanics Gupta, Kumar, Pragati Prakashan.

M.SC-I, SEME. II, PHYSICS (APPLIED ELECTRONICS)
SCT – 2.2: ELECTRONIC INSTRUMENTATION
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Transducers (15)

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 (15)

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 (15)

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 (15)

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-I, SEME. II, PHYSICS (APPLIED ELECTRONICS)
OET - 2.1: FUNDAMENTALS OF ELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

UNIT 1 : Electronic Components (15)

Circuit concept Units, Standards and Dimensions. Electric current, Electric charge, potential difference, Electric power and Energy. Circuit elements: Passive elements and active elements. Network Law's, Junction Law's (KCL), Mesh Law's (KVL) Application of Network Law's to simple dc networks theorems – Thevenin's theorem, Norton's theorem Max power transfer theorem.

UNIT 2 : Semiconductor Devices (15)

Junction Diodes, p-n junction, an unbiased p-n junction, a biased p-n junction and V-I characteristics of p-n junction. Some special P-N junction: - Photodiodes, LED and Solar Cell. Junction transistor, Transistor static characteristic Self-bias or emitter bias, Two-port representation of Transistor (hybrid parameter) JFET: Static Characteristic of FET comparison of FET with Bipolar transistor.

UNIT 3: Applications of Active & Passive (15)
Operational Amplifier Characteristics and Applications

Introduction, Ideal Op-Amp, DC and AC Characteristics: Instrumentation Amplifier, V to I and I-V converter Precision rectifier, Differentiator and Integrator. Comparator Schmitt trigger wave generators (Square wave and Triangular wave) and first order Low pass and High pass filters.

UNIT 4: Special IC series (15)

Op-Amp regulator, Design of power supplies using voltage regulator ICs, 555 Timer as Monostable and Astable operation.

Reference books:

1. D Chattopadhyaya, P.C. Rakshit, B Saha and N NPurkait: Foundations of Electronics, New Age International Edition.
2. D. Roy Choudhary and ShailJain : Linear Integrated Circuit, New Age International (P) Ltd.
3. P-Amp and Linear Integrated Circuits : R. A. Gaikwad, PHI of India Ltd.
4. A Texbook of Electronics (Second Edition) : S. L. Kakani and K. C. Bhandari
5. Electronic Principles : A. P. Malvino, TMH Edition.

M.SC-I, SEME. II, PHYSICS (APPLIED ELECTRONICS)
OET - 2.2: Conventional & Nonconventional Energy
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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. Cathode-ray 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.

Unit 2: 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 2020-2021)

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.

_____xxxx_____

M.SC-I, SEME. I, PHYSICS (MATERIALS SCIENCE)
HCT - 1.1: MATHEMATICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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:

8. Introduction to Mathematical Physics by C. Harpcr, Prcnticc - Hall of India Ltd. N.Delhi 1993,(Chapters 2,4,6,9)
9. Mathematical Physics by A.G. Ghatak, I.C.Goyal and S.J.Chua, McMillan India Ltd. New Delhi 1995 (Chapters 4,7,9,10)
10. Matrices and Tensors for Physicists,by A W Joshi
11. Advanced Engineering Mathematics, by E Keryszig
12. Mathematical Method for Physicits and Engineers, by K F Reily, M P Hobson and S J Bence
13. Mathematics for Physicists by Mary L B
14. Mathematical Methods for Physics, by G Arfken

M.SC-I, SEME. I, PHYSICS (MATERIALS SCIENCE)
HCT - 1.2: SOLID STATE PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Crystal Structure (15)

Basic Structures, Bravais systems in 2D and 3D, Bonding in solids, Reciprocal Lattice, Diffraction by X-ray and structure factor, Point defects and dislocations,
Specific Heat: Lattice vibration, Phonons, Einstein and Debye's theories.

Unit II: Energy bands and Semiconductors (20)

Energy bands:
Metal, Insulator and Semiconductor, Bloch theorem, Electron in periodic potential -1D, Tight and loose band approach, Brillion's Zones, Fermi surfaces.

Semiconductors:
Direct and indirect band gap semiconductors, Effective mass, Hall effect and thermoelectric power, Intrinsic and Extrinsic carrier concentration.

Unit III: Dielectrics (10)

Electronic, Ionic, Orientational polarizations, Clausius-Mossotti equation, Dipole theory of ferroelectricity, Internal field in solids, Classification of magnetic materials,

Unit IV: Superconductors (15)

Basic concept, Meissner effect, Types I and II, Thermal properties of superconductor,
Thermodynamics of superconductors, London equation, Josephson tunneling and its theory, BCS theory.

Reference Books:

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

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

8) Solid State Physics S.O.Pillai (New age international limited

Publications)

9) Solid State Physics by Saxena and Gupta(Pragati Editions)

10) Solid State Physics by Rita John (Mc Graw Hill)

M.SC-I, SEME. I, PHYSICS (MATERIALS SCIENCE)
HCT - 1.3: ANALOG & DIGITAL ELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-21)

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 Feedback, Effect of feedback 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,

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, Multiplexers and Demultiplexers

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 /Subtraction, 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 (MATERIALS SCIENCE)
SCT - 1.1: CLASSICAL MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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:

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

M.Sc-I, SEME. I, PHYSICS (MATERIALS SCIENCE)
SCT– 1.2 (MS): ELEMENTS OF MATERIALS SCIENCE
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 ((MATERIALS SCIENCE)
HCT - 2.1: QUANTUM MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 HartreeFockself 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:

4. Introductory Quantum Chemisty (3rd Ed^{n}), A. K. Chandra (Tata McGraw Hill).

5. Quantum Chemistry (4th Edition) - Ira N. Levine (Prentice Hall) of India Pvt. Ltd. New Delhi. 1995.

6. A textbook of Quantum Mechanics - P M Mathews, K Venkatesan. (Tata McGraw Hill).

M.SC-I, SEME. II, PHYSICS (MATERIALS SCIENCE)
HCT - 2.2: ELECTRODYNAMICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (MATERIALS SCIENCE)
SCT - 2.1: STATISTICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Statistical Thermodynamics: (20)

2. Thermodynamic systems and equilibria, Laws of thermodynamics and their consequences, Nernst heat theorem, Microstates and microstates, Postulate of equal priori probability, Probability calculations, Thermodynamic potentials and Maxwell's relations, Chemical potential, phase equilibria, Black Body radiation and planks distribution, Phase equilibria, Free energy and its connection with thermodynamic quantities, entropy of mixing and Gibbs and paradox.

3.

4. Unit II: Classical statistical mechanics: (15)

5. Statistical ensembles, Microcanonical ensemble- system in contact with heat revisor, Condition for thermal equilibrium, canonical ensemble – molecular ideal gas and grand canonical ensemble, Liouville's theorem, Ensembles, Maxwell Boltzmann distribution, classical ideal gas,

6.

7. **Unit III: Quantum Statistical Mechanics (15)** Phase space (Diagram of an oscillator), Maxwell- Boltzmann statistics, Fermi-Dirac statistics and Bose- Einstein statistics, Liouville's theorem, Ideal Bose gas, Ideal Fermi gas- weekly and strongly degerate , Bose- Einstein condensation.

8.

9. **Unit IV: Phase transitions and critical phenomena (10)** Phase transition, Triple Point, Condition for phase equilibrium, First order phase transition, Ehrenfests equations, Clausius-Clayperon equation, Second latent heat equation, Examples, Second order phase transition, Critical indices, The law of corresponding states.

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
4) Text Book of statistical mechanics. Suresh Chandra, CBS Publications
5) Elementary Statistical Mechanics Gupta, Kumar, Pragati Prakashan.

M.SC-I, SEME. II, PHYSICS (MATERIALS SCIENCE)
SCT - 2.2: ANALYTICAL TECHNIQUES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (MATERIALS SCIENCE)
OET - 2.1 : FUNDAMENTALS OF ELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

UNIT 1 : Electronic Components (15)

Circuit concept Units, Standards and Dimensions. Electric current, Electric charge, potential difference, Electric power and Energy. Circuit elements : Passive elements and active elements. Network Law's, Junction Law's (KCL), Mesh Law's (KVL) Application of Network Law's to simple dc networks theorems – Thevenin's theorem, Norton's theorem Max power transfer theorem.

UNIT 2 : Semiconductor Devices (15)

Junction Diodes, p-n junction, an unbiased p-n junction, a biased p-n junction and V-I characteristics of p-n junction. Some special P-N junction: - Photodiodes, LED and Solar Cell. Junction transistor, Transistor static characteristic Self-bias or emitter bias, Two-port representation of Transistor (hybrid parameter) JFET: Static Characteristic of FET comparison of FET with Bipolar transistor.

UNIT 3: Applications of Active & Passive (15)
Operational Amplifier Characteristics and Applications

Introduction, Ideal Op-Amp, DC and AC Characteristics: Instrumentation Amplifier, V to I and I-V converter Precision rectifier, Differentiator and Integrator. Comparator Schmitt trigger wave generators (Square wave and Triangular wave) and first order Low pass and High pass filters.

UNIT 4: Special IC series (15)

Op-Amp regulator, Design of power supplies using voltage regulator ICs, 555 Timer as Monostable and Astable operation.

Reference books:

6. D Chattopadhyaya, P.C. Rakshit, B Saha and N NPurkait: Foundations of Electronics, New Age International Edition.

7. D. Roy Choudhary and ShailJain : Linear Integrated Circuit, New Age International (P) Ltd.

8. P-Amp and Linear Integrated Circuits : R. A. Gaikwad, PHI of India Ltd.

9. A Texbook of Electronics (Second Edition) : S. L. Kakani and K. C. Bhandari

10. Electronic Principles : A. P. Malvino, TMH Edition.

M.SC-I, SEME. II, PHYSICS (MATERIALS SCIENCE)
OET - 2.2: Conventional & Nonconventional Energy
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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

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 (MATERIALS SCIENCE)
HCT - 3.2: ATOMIC and MOLECULAR PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (Materials Science)
SCT– 3.1 (MS): DIELECTRIC AND FERROELECTRIC PROPERTIES OF MATERIALS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Introduction (10)

Maxwells equations, Amperes law, Faradays law, Gauss law in presence of dielectric, Electric field, Electric flux density, Polarization, Permittivity, electric susceptibility, Dipole moment , Polar and non-polar dielectrics.

Unit II: Electric Polarization and Relaxation (20)

Fundamentals: Force acting on the boundary between two different dielectric materials, Force elongating a dielectric fluid, Dielectrophoretic force, Electrostriction force, Electrostatic induction , Electric polarization and relaxation in static electric fields, Vacuum space, Conducting materials.

Dielectric Materials and its Polarization: Mechanism of electric polarization, Electronic polarization, Classical and Quantum Mechanical Approach, Atomic or Ionic Polarization, Orientational polarization, Polarizability, Spontaneous polarization, Space charge polarization, Hopping polarization, Interfacial polarization, Classification of dielectric materials, Non-ferroelectric and ferro-electric materials, Internal fields, Local fields for Non-dipolar materials, Clausius-Mosotti Equation.

Dielectrics in AC field: Lorentz - Lorenz equation, Reaction Field for dipolar materials, Electric polarization and relaxation in time -varying electric fields, Time domain approach and the frequency - domain approach, Complex permittivity, Time dependent electric polarization, Kramers - Kronig equations, Debye equations, Absorption, and Dispersion for dynamic polarizations, Effects of the local field, Effects of DC conductivity, Cole - Cole plot, Temperature dependence of complex permittivity, Field dependence of complex permittivity of ferroelectric materials, Insulating materials, Dielectric relaxation phenomena.

Unit III: Optical and Electro-Optic Processes (10)

Modulation of light, Double refraction and birefringence, Quarter - Wave plate, Electro - Optic effects: Linear Electro – Optic effect, Photorefractive effect, Magneto - Optic effect, Faraday effect, Voigt effect, Acousto-Optic effect.

Unit IV: Ferroelectrics, Piezoelectrics and Pyroelectrics (20)

Ferroelectrics: Ferroelectric phenomena, Representative crystal, types of ferroelectrics: Properties of Rochelle salt, $BaTiO_3$, Theory of ferroelectric displacive transitions, Thermodynamic theory, Ferroelectric and antiferroelectric transition, Formation and dynamics of ferroelectric domains, Experimental evidence of domain structure, Applications of ferroelectric materials

Piezoelectrics: Piezoelectric phenomena, Phenomenological approach to piezoelectric effects, Piezoelectric parameters and their measurements, Piezoelectric materials and their applications.

Pyroelectrics: Pyroelectric phenomena, Phenomenological approach to pyroelectric effects, Pyroelectric parameters and their measurements, Pyroelectric and thermally sensitive materials, NTC and PTC materials, Applications of pyroelectric materials.

References Books:

1. Kwan Chi Kao and F. R. de Boer; Dielectric Phenomena in Solids, Elsevier Academic Press (2004).
2. J. P. Srivastava, Elements of Solid State Physics, 2nd Edi Prentice – Hall of India(P) Ltd. (2007)
3. Charles Kittle; Introduction to Solid State Physics, 7th Edition, John Wiley & Sons, (1996).
4. Saxena, Gupta, Saxena; Fundamentals of Solid State Physics, Pragati Prakashan, (2012).
5. A. J. Dekkar; Solid State Physics, 1st Ed. Macmillan (2000).
6. M.A.Wahab; Solid State Physics: Structure and Properties of Materials, Alpha Science International (2005)
7. S.O. Pillai; Solid State Physics, 6th Ed., New Age International (p) Ltd publishers, (2005)
8. Neil W. Ashcroft, N. David Mermin, Solid State Physics; Saunders College, (1976).

M.Sc-II, SEME. III, PHYSICS (MATERIALS SCIENCE)
SCT– 3.2 (MS): MATERIAL PROCESSING
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I : Vacuum Technology (12)

Principles of vacuum pump – principle of different vacuum pumps : roots pump, rotary, diffusion turbo molecular pump, cryogenic-pump, ion pump, ti-sub limitation pump, importance of measurement of vacuum, Concept of different gauges, bayet - albert gauge, pirani, penning, pressure control.

Unit II: Physical Vapor Deposition & CVD Techniques (12)

Thermal evaporation, resistive evaporation, Electron beam evaporation, Laser ablation, Flash and Cathodic arc deposition, laser ablation, laser pyrolysis, molecular beam epitaxy, electro deposition.

Chemical Vapor Deposition Techniques (12)

Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types boundaries and flow, Different kinds of CVD techniques: Atmospheric pressure CVD (APCVD) – Low pressure CVD (LPCVD) – Plasma enhanced chemical vapor deposition (PECVD) or –The HiPCO method – Photo-enhanced chemical vapor deposition (PHCVD) – LCVD Laser –Induced CVD, Metallorganic CVD (MOCVD), Thermally activated CVD, Spray pyrolysis,etc.

Unit III : Electrical Discharges used in Thin Film Deposition(10) Sputtering, Glow discharge sputtering, Magnetron sputtering, Ion plating, oxidizing and Nitriding, Atommic layer deposition (ALD), Importance of ALD technique, Atomic layer growth.

Unit IV : Conditions for the Formation of Thin Films (12)

Environment for thin film deposition,deposition parameters and their effects on film growth, formation for thin films (sticking coefficient, formation of thermodynamically stable cluster – theory of nucleation), capillarity theory, microstructure in thin films, adhesion, properties of thin films, Mechanical ,Electrical, and optical properties of thin films, few applications of thin films in various fields, Quartz crystal thickness for measurement of film thickness.

Unit V :Adsorption And Diffusion in Thin Films (12)

Physisorption – Chemisorption –Work function changes induced by induced by adsorbates – Two dimensional phase transititions in adsorbate layers – Adsorption kinetics – Desorption techniques. Fundamentals of diffusion – Grain Boundary Diffusion –Thin Film Diffusion Couples –Inter Diffusion –Electromigration in thin films –Diffusion during film growth, Stress in Thin Films.

Reference Books:

1. Hand book of Thin films Technology: L I Maissel and R Clang.
2. Thin film Phenomena: K L Chopra.
3. Physics of thin films,vol.12,Ed George Hass and others.

4. Vacuum deposition of thin films – L Holland.

5. Milton Ohring,Materials Science of Thin films Published by Academic Press Limited (1991)

6. L.B.Freund and S.Suresh, Thin Film Materials,(2003)

7. Hans Luth, Solid Surfaces, Interfaces and Thin Films' 4th edition,Springer Publishers (2010)

8. HaraldIbach, Physics of Surfaces and Interfaces, Springer Publishers (2006).

AMY R L Banshow

M.Sc-II, SEME. IV, PHYSICS (MATERIALS SCIENCE)
SCT –3.3: MATERIALS CHARACTERIZATION
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: (12)

Introduction to the Common Concepts in Materials Characterization:

Measurements of Mass and Density, Different kinds of Balances. Roughness, Porosity and Surface area measurement. Microscopic tools and necessity, Spectroscopic tools and necessity, Resonance techniques and necessity, Surface properties and the necessary tools, Understanding Crystallinity, Thermal properties and thermal analysis like thermal conductivity ,specific heat, melting temperature and other phase transitions using TG,DTG,DTA etc. Methods of Temperature measurements, Hardness of material measurements and associated Physics, Materials aspects: particles, bulk, thin and thick films, gel, suspension and rheological properties. General behavior of metals, ceramics, semiconductors, polymers and tools required to characterize them, Methods of Sample preparation: polishing, grinding, sectioning, annealing, sintering, etching.

Errors in measurements, Analysis of errors, Curve Fitting. Standard Distribution functions, International Standards: ASTM and other standards

UnitII : Vacuum Techniques (12)

Fundamental concept of vacuum, units of measurements, Kinetic theory of gases. practical aspects of vacuum technology: vapor pressure, out-gassing, seals, pumping speeds, conductance, through puts. Order of vacuum and necessity during the material characterization

Vacuum pumps: Mechanical pumps ,Water pumps, Rotary oil pumps, Roots pumps,

Unit III: Structural analysis of materials by X-ray diffraction analysis (12)

Introduction to generation and detection of X-rays, Crystalline, polycrystalline ,nano-crystalline and amorphous solids. Laue method for single crystal structural analysis. Powder diffraction methods, Analysis of cubic structures, introduction to crystal symmetry and crystal structure, Factors affecting the intensity in Powder XRD, Structure factor , few examples of NaCl, KCl, KBr etc.. Different X-Ray Cameras and geometries.

Unit IV: Characterization of Electrical Properties (12)

Electrical transport in metals, semiconductors and insulators and difficulty in measurements, Bulk conductivity , practical aspects of methods , Surface conductivity measurements ,Four probe method of conductivity measurement,Van der Pauw measurement for an arbitrary shape ,Practical aspects and problems, Non contact mode of conductivity measurement.Microwave techniques, Hall effect in semiconductors, Hall mobility measurements. Measurement of Introduction to Deep Level Transient Spectroscopy (DLTS).Electrical conductivity with temperature ,Defects in semiconductors and their measurements .Estimation of mobility band gap in semiconductors, Photoconductivity,

Unit V: Characterization of Optical Properties (12)

Introduction to electromagnetic (EM) spectrum Energy wavelength and frequencies of EM radiations. Interaction of EM radiations with matter in different regions of EM spectral regions. Absorption. Reflection and Transmission in materials, Beer Lambert Law. Laboratory sources of EM radiations, Basic definition of spectrometer .and its components. Vibrational spectroscopy for determining the molecular bonds and structure, UV-Visible absorption spectroscopy, Its use to

determine the Band gap of semiconductors ,Refractive index of thin films, Factors affecting the absorption. Photoluminescence (PL) spectroscopy for understanding the band gap solids.

Reference Books:

1)“Charecterization of Materials”, Elton N.Kaufmann,Vol I & II ,Wiley Interscience,2003.
2)Elements of X-Ray Diffraction”,CulityB.D.,Addison Wesley Publishing Company.
3)“Fundamentals of Molecular Spectroscopy” ,C.N.Banwell,Tata McGraw–Hill Publishing Company Limited
4)“Instrumental Methods of Analysis” ,H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, CBS Publishers & Distributors, Delhi.
5)“X-Ray Diffraction”, C.Suryanarayana and Grant Norton,SpringerScience+Business Media, LLC
6) Absorption Spectroscopy, Bauman R.P., Wiley .New York

M.Sc-II, SEME. IV, PHYSICS (Materials Science)
OET - 3.1: ENERGY HARVESTING DEVICES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit -1: Solar Cells (15)

Photovoltaic effect, Solar cell characterization, Types of Solar cells, Solid state solar cells Silicon solar cell, CdTe based solar cells, CdS/Cu_2S solar cells, $CuInSe_2$ based solar cells, Metal-semiconductor solar cells, photoelectrochemical and photo electrolysis cells, Solar cells based on thin film heterojunctions, Ultra thin absorber solar cells, Nanostructured solar cells, Dye sensitised solar cells: basic concepts, working and materials. Organic Solar cells: basic concepts, working and materials.

Unit -2: Super Capacitors (15)

Comparison of battery and super capacitors, Super capacitor characterization, Types of super capacitors, double layer and pseudo capacitance, hybrid super capacitors, Recent status of carbon, RuO_2 and polyaniline based super capacitors, different methods for preparation of cathodic and anodic electrode materials, Fabrication of super capacitors with examples, Applications of supercapacitors

Unit -3: Fuel Cells (15)

Comparison between fuel cells and batteries, fuel cell characterizations, Types of fuel cells: Metal oxide, proton exchange membrane, Phosphoric acid, Solid oxide fuel cells, working of fuel cells, Materials for fuel cells, applications of fuel cells

Unit -4: Piezoelectrics (15)

Piezoelectric Energy Harvesting: Energy harvesting basis, case study

Piezoelectric Materials: Piezoelectric polycrystalline ceramics,Piezoelectric Single Crystal Materials, Piezoelectric and Electrostrictive Polymers, Piezoelectric Thin Films.

Piezoelectric transducers, Mechanical energy harvester using Laser Micromachining, Mechanical energy harvester using PlezoelectricFibers, Piezoelectric Microcantilevers, Energy harvesting circuits, Multimadal energy harvesting, Mangetoelectric composites,

Introduction to Piezoelectric bulk Power generators, Piezoelectric Micro Power Generators, Conversion efficiency, Power storage circuits

Reference Books

1. Semiconductor Sensors, S M Sze, A Wiley- Interscience Publication, John Wiley and Sons, NY1994
2. Electrochemical Supercapacitors, B E Conway, Kluwer Academic/ Plenum publishers, NY 1999.
3. C. N. R. Rao and Claudy Rayan Serrao, J. Mater. Chem., 2007, 17, 4931–4938
4. Solar Cells by Martin Green.
5. Photoelectrochemical Solar Cells by S. Chandra, Gordon &Breach Science Publisher, UK
6. Energy Harvesting Technologies, ShashankPriya, Daniel J. Inman Springer

M.Sc-II, SEME. IV, PHYSICS (Materials Science)
OET - 3.2: NUCLEAR RADIATION & EFFECTS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-21)

Unit-1: Interaction of Charged Particles with Matter (10)

Introduction to Charged Particles, Theory and general features for charged particles - the Bethe-Bloch equation, Photon interactions - photoelectric effect, Compton scattering, Pair production, Neutron scattering and absorption, Attenuation and shielding. **(J S Lilley),** Interaction of Heavy Charged Particles, Interaction of Fast Electrons, Interaction of Gamma Rays, Interaction of Neutrons **(Glenn F Knoll)**

Unit-2: Nuclear Radiation Units (08)

The Roentgen and the Rad, Photon Flux and Radiation Dose, Dose rate and radioactive source strength, Radiation dose from internal source, The Rem, Gray, Rad to Gray Conversion, Fluence **(Samuel Glasstone)**

Unit-3: Radiation effects on Semiconductor Materials (12)

Basic Radiation Damage Mechanisms in Semiconductor Materials and Devices:Introduction. Fundamental Damage Mechanisms: Ionization Damage, Displacement Damage. Impact ofRadiation Damage on Device Performance: Spectroscopic Study of Microscopic Radiation Damage: Electron Paramagnetic Resonance (EPR), Deep Level Transient Spectroscopy (DLTS), Photo-luminescence Spectroscopy (PL)

Displacement Damage in Group IV Semiconductor Materials: Introduction, Displacement Damage in Silicon: Radiation Defects in Silicon, Impact of Radiation Defects on Silicon Devices, Substrate and Device Hardening, Displacement Damage in Germanium: Potential Applications of Ge, Cryogenic Irradiation of Ge, Room Temperature Irradiation of Ge, Impact Radiation Damage on Ge Materials and Device Properties, Displacement Damage in SiGe Alloys: SiGe Material Properties and Applications, Radiation Damage in SiGe, Processing-Induced Radiation Damage in SiGe, Radiation Damage in SiGe Devices **(C. Claeys)**

Unit-4: Biological Effects of Radiation (15)

Introduction, Somatic effects of radiation, genetic effects of radiation, The radiation back ground, Radiation dose from nuclear power operations, estimates of biological consequences. **Radiation Hazards:** Health-physics activities, Effects of different types of radiation, External and internal radiation sources, Protection from radiation hazards. **(Samuel Glasstone)**

Unit-5: Useful Applications of Nuclear Radiation: Nuclear Medicine (15)

Production of various radioactive isotopes, application of the isotope in therapeutic process like gamma ray therapy, boron neutron capture therapy, heavy ion therapy applications of radioisotopes in imaging process like, gamma camera, positron emission tomography and magnetic resonance imaging are discussed. **(Fieldmen &Soete)**

TEXT BOOKS

1. Gnell F Knoll, Radiation Detectibn and Measurement, Third Edition, John Willey, 2000
2. John S Lilley, Nuclear Physics Principles and Applications, Willey, 2001

3. C. Claeys E. SimoenRadiation Effects in Advanced Semiconductor Materials and Devices, Springer
4. S. Glasstone and A. Sesonske, Nuclear Reactor Engineering, D. Van Nostrand Company, INC. 1967.
5. De Soete, D. R. Gijbels and J. Hoste, Neutron Activation Analysis. John Wiley and Sons: New York, NY. (1972).

6. L. C. Feldmen and J. W. Mayer, Fundamentals of surface and thin films analysis, North-Holland, Elsevier, 1986.

REFERENCE BOOKS

1. Robley D Evans, The Atomic Nucleus, TMH, 1955
2. L. Cohen, Concepts of Nuclear Physics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.

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

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 (MATERAILS SCIENCE)
HCT - 4.2: NUCLEAR AND PARTICLE PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (Materials Science)
HCT - 4.3: PHYSICS OF NANO MATERIALS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Introduction (15)

Background of Nanoscience and Nanotechnology, Definition of Nanoscience and Nanotechnology, Possible Applications of Nanotechnology, Top-down and Bottom-up approach (Brief).

Band Structure and Density of States at Nanoscale: Introduction, Energy Bands, Density of States at Low - dimensional Structures, Quantum confinement – semiconductors, quantum wells, quantum wires, quantum dots, quantum rings. Manifestation of quantum confinement, quantum confinement effect, dielectric quantum confinement, effective mass approximation, core-shell quantum dots.

Unit II: Properties of Nanomaterials (15)

Optical properties: Absorption, transmission, Beer-Lamberts law (derivation), Photoluminscence, Fluorescence, Phosphorescence, Cathodoluminscence, Electroluminescence, Surface Plasmon resonance (SPR), effect of size of nanoparticles (metal, semiconductor) on absorption and SPR spectra.

Electrical transport: Electrical Conduction in Metals, Classical Theory - The Drude Model Quantum Theory - The Free Electron Model Conduction in Insulators/Ionic Crystals, Electron Transport in Semiconductors, Various Conduction Mechanisms in 3D (Bulk), 2D(Thin Film) and Low – dimensional Systems**,** Thermionic Emission Field – enhanced Thermionic Emission (Schottky Effect), Field - assisted Thermionic Emission from Traps (Poole - Frenkel Effect), Hopping Conduction, Polaron Conduction.

Unit III: Growth Techniques and Characterization Tools of Nanomaterials (20)

Growth techniques: Introduction, Top - down vs. Bottom - up Technique, Lithographic Process and its limitations , Nonlithorgraphic Techniques ,Plasma Arc Discharge Sputtering ,Evaporation, Chemical Vapour Deposition ,Pulsed Laser Deposition ,Molecular Beam Epitaxy, Sol - Gel Technique , Electrodeposition , Different chemical routes, Other Processes.

Characterization Tools of Nanomaterials: Scanning Probe Microscopy (SPM): Introduction, Basic Principles of SPM Techniques, The Details of scanning Tunneling Mocroscope (STM), General Concept and Definite Characteristics of AFM, Scanned - Proximity Probe Microscopes Laser Beam Deflection, AFM Cantilevers ,Piezoceramics, Feedback Loop Alternative Imaging Modes. Electron Microscopy: Introduction, Resolution vs. Magnification Scanning Electron Microscope SEM Techniques, Electron Gun Specimen Interactions Environmental SEM (FESEM), Transmission Electron Microscope, High Resolution TEM Contrast Transfer Function. Near-field scanning optical microscopy (SNOM/NSOM), UV-Vis single and dual beam spectrophotometer, photoluminescence spectrometer, X-ray diffractometer. Surface area and Pore size measurements (BET Analysis)

Unit IV: Some Special Topics in Nanotechnology (10)

Introduction ,The Era of New Nanostructure of Carbon Buckminsterfullerene, Carbon Nanotubes, Nanodiamond, BN Nanotubes Nanoelectronics ,Single Electron Transistor, Molecular Machine, Nano-biometrics.

Reference Books:

1) Introduction to Nanoscience and Nanotechnology: K.K. Chattopadhyay and A.N. Banerjee, PHI Publisher
2) Nanoscience and Technology: V. S. Murlidharan, A. Subramanum.
3) Nanotubes and Nanofibers:YuryGogotsi
4) A Handbook of Nanotechnology : A. G. Brecket
5) Instrumentations and Nanostructures: A. S. Bhatia
6) Nanotechnology: Nanostructures and Nanomaterials - M. B. Rao
7) Nanotechnology-Principles and practices - S. K. Kulkurni (Capital Publication Company)

M.Sc-II, SEME. IV, PHYSICS (Materials Science)
SCT - 4.1: ADVANCED TECHNIQUES OF MATERIALS CHARACTERIZATION
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Microscopic Techniques: (10)

Optical Microscopy and limitations: Principle of Diffraction of light, Airy Disc, Resolution and magnification; Rayleigh Criteria, Numerical aperture, Major lens defects. Different kinds of optical microscopes (Bright field, Stereo, Phase contrast, Differential Interference Contrast, Fluorescence, Confocal, Polarizing light microscope)

Unit-II: Electron Microscopy (20)

Limitations of Light microscopy and advantages of electron microscopy. Wavelength of electrons, Theoretical Resolving power, Source of electron emission .Electron Focusing, Effect of magnetic fields, Electrostatic and magnetic focusing, Optical Column, Magnetic lenses. Vacuum requirements. Schematic of complete SEM

Scanning Electron Microscopy (SEM): Interaction of electrons with matter. Secondary electron emission (SEE), Yield of SEE, Universal yield curve, Beam scanning and Magnification in SEM, Secondary electrons Detector, Back scattered electrons detector. Electronics. Image analysis. Size histogram. Sample preparation.

Transmission Electron Microscopy(TEM) : Principle of operation, Lens systems, Schematic of TEM ,Apertures, Bright Field Image, Dark Field Image ,.Electron Diffraction, Bragg's Condition, Selective Area Electron Diffraction (SEAD), Image analysis. Sample preparation

Scanning Tunneling Microscopy

Historical perspective, Electron tunneling ,Principle of STM imaging , STM image interpretation ,STM implementation in instrument , Piezoelectric drive, Tip preparation, Vibration isolation, Data acquisition and analysis, Application of STM , high resolution imaging of surfaces, Spectroscopy, Lithography, Current fluctuation, Limitation of STM and solution,

Atomic Force Microscopy: Principle and equations of force curves, Contact and Non contact modes, Amplitude modulation and Frequency modulation, Force versus distance curve, Experimental details of AFM, Practical applications.

Unit III: X-Ray Photoelectron Spectroscopy (15)

Definition of surface, Different Probes for Surface-characterization. Necessity of Ultra High Vacuum, Photoelecton Emission, Introduction and Basic Theory, Historical Perspective, Instrumentation, Vacuum System. Energy analyzers, X-Ray Source, Electron Energy Analyzer. Sample Selection and Preparation , Sample Charging .X-Ray Beam Effects., Spectral Analysis ,Core Level Splitting .,Linewidths. Elemental Analysis: Qualitative and Quantitative, Secondary Structure, Angle-Resolved XPS, Depth profiling.

Unit IV. Raman and Resonance spectroscopy: (15)

Raman Effect and Raman spectroscopy: Classical and Quantum theory of Raman Effect, Rotational and vibrational structure of Raman spectrum - pure rotational Raman spectra of diatomic molecules, vibration rotation Raman spectrum of diatomic molecule, intensity alterations, Application of Raman spectroscopy.

Resonance Technique: NMR – nuclear spin magnetic moment, interaction of nuclear magnet with external field. Quantum description of N.M.R., NMR spectrometer, Chemical shift, Spin–spin interaction, Applications of NMR spectroscopy.

Reference Books:

1) Handbook of Applied Solid State Spectroscopy, D. R. Vij, Springer
2) Phtoelectron and Auger Spectroscopy, T.A.Carlson, Plenum Press , 1975
3) Practical Guide to Surface Science and Spectroscopy,Yip-WahChung,Academic Press
4) Fundamental of Molecular Spectroscopy, C.N.Banwell, TataMc-Graw Hill.

M.Sc-II, SEME. IV, PHYSICS (Materials Science)
SCT - 4.2: MAGNETIC MATERIALS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Introduction (15)

Measurement of Field Strength, Hall Effect, Electronic Integrator or Flux meter, Magnetic Measurements in Closed Circuits, Demegnetizing Fields, Magnetic Shielding, Demagnetizing Factors, Magnetic Measurements in Open Circuits, Instruments for Measuring Magnetization, Vibrating - Sample Magnetometer, Altering (Field) Gradient Magnetometer - AFGM or AGM, (also called Vibrating Reed Magnetometer), Magnetic Circuits and Parameters, Permanent Magnet Materials, Susceptibility Measurements.

Unit II: Magnetism in Materials (20)

Diamagnetism and Para magnetism:

Introduction, Magnetic Moments of Electrons, Magnetic Moments of Atoms, Theory of Diamagnetism, Diamagnetic Substances, Classical Theory of Para magnetism, Quantum Theory of Para magnetism, Gyro magnetic Effect, Magnetic Resonance

Ferromagnetism: Introduction, Molecular Field Theory, Exchange Forces, Band Theory, Ferromagnetic Alloys, Theories of Ferromagnetism

Antiferromagnetism: Introduction, Molecular Field Theory, Above $T_{N,}$ Below $T_{N,}$ Comparison with Experiment, Neutron Diffraction, Antiferromagnetic, Ferromagnetic, Rare Earths , Antiferromagnetic Alloys.

Ferrimagnetism: Introduction, Structure of Cubic Ferrites, Saturation Magnetization, Molecular Field Theory, Above Tc, Below Tc, General Conclusions, Hexagonal Ferrites, Other Ferromagnetic Substances, y - $Fe_2O_{3,}$ Garnets, Alloys.

Unit III: Magnetic Anisotropy, Magnetostriction and the Effects of stress

(15)

Magnetic Anisotropy: Introduction, Anisotropy in Cubic Crystals, Anisotropy in Hexagonal Crystals, Physical Origin of Crystal Anisotropy, Anisotropy Measurement, Torque Curves, Torque Magnetometers, Anisotropy Measurement (from Magnetization Curves), Fitted Magnetization Curve, Anisotropy Constants, Polycrystalline Materials

Magnetostriction: Introduction, Magnetostriction of Single Crystals, Cubic Crystals, Magnetostriction of Polycrystals, Physical Origin of Magnetostriction, Form Effect, Effect of Stress on Magnetic Properties, Effect of Stress on Magnetostriction, Applications of Magnetostriction, ΔE Effect, Magnetoresistance.

Unit IV: Domains and the Magnetization Process (10)

Introduction, Domain Wall Structure, Neel Walls, Magnetostatic Energy and Domain Structure, Uniaxial Crystals, Cubic Crystals, Domain Wall Motion, Magnetization in Low Fields, Magnetization in High Fields, Shapes of Hysteresis Loops.

Reference Books:

1. K. H. J. Buschow& F. R. de Boer: Physics of Magnetism and Magnetic Materials.

2. C. Kittle: Introduction to Solid State Physics.

3. Azoroff : Introduction to Solids.
4. Saxena, Gupta, Saxena: Fundamentals of Solid-state Physics.
5. R. L. Singhal: Solid State Physics.
6. V. Raghavan: Materials Science and Engineering.
7. A. J. Dekkar: Solid-state Physics.

M.SC-, PHYSICS (MATERIALS SCIENCE)
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)
Practical List

HCP 1.1/1.2/1.3

1) Determination Band gap of Ge Diode.
2) Crystal Structure FCC type.
3) Temp. Variation of Breakdown voltage of zerer diode.
4) Temperature Transducer (Thermister).
5) P.N. Junction capacitance.
6) LVDT.
7) Photovoltaic cell.
8) Hall Effect.
9) CC with CC Amplifier.
10) DC Amplifier.
11) Voltage Regulator
12) Astablenultivibrator (using IC741Op Amp)
13) Op-Amp Phase Lead Circuit.
14) Op-Amp Phase Lag circuit.
15) Verificaiton of De Morgans theorem.
16) Wein Bridge Oscillator.
17) Op-Amp Phase shift Oscillator.
18) Negative feedback Amplifier.
19) D.T.L. gates.
20) Study of filters.
21) Transistor Biasing.
22) CE amplifier Desing.
23) FET characteristics and Designing of Amplifier.
24) Divide by 2 Divide by 5 & Divide by 10 counter using IC-7490.

SCP 1.1/1.2

1) Op-Amp (Adder, Subtractor, Integratorc, Differentiator).
2) Op-Amp I to V, V to I converter.
3) Voltage source.
4) Constant current source (floating load).
5) Constant current source (Grounded load).
6) Variable duty cycle MV using Op-Amp.

HCP 2.1/2.2

1) Wave form generator (square & triangular)
2) Twin T network.
3) Bear Lamberts law

4) Resistivity by four probe method.
5) Strain gauge I.
6) Lattice prarameter&particlesiretestimation.
7) Op-Amp instrumentation amplifier IC324.
8) Characteristics of UJT.
9) Electrodepositon of Mn.
10) Op-Amp. Parameters.

SCP 2.1/2.2

1) Study of thermocouple &thermister.
2) Intensity calculation.
3) Crystal structure I.
4) Crystal structure II.
5) Study of phase diagram.
6) Hall Effect II.

OEP 2.1/2.2

13) Transister Parameters.
14) Op-Amp inverting and non-inverting amplifiers.
15) Monostablemultivibratorvsing IC555.
16) FET charaterishes.
17) Op-Amp Adder.
18) Op-Amp subtractor.
19) First order High pass filter.
20) First order Low pass filter.
21) Determination of optical gap.
22) Determination of optical absorption by materials & hence determination of type of transition.
23) Study of p.n. junction photo voltaic.
24) Characterization of a PV cell in dark & in light & hence determination of junction ideality factor.

HCP 3.1/3.2

1) Susceptibility measurement of $FeCl_3 6H_2O$ solution.
2) Successive Ionic Layer Adsorption and Reaction.
3) Chemical Bath deposition of PbS.
4) Chemical Bath deposition of CdS.
5) Strain gauge II.
6) Optical studies on CdS thin film (α vs λ, determination of E_g and m).
7) LVDT II.
8) Band gap determination using four probe method.
9) Hydroxide co-precipitation of $Ba_{0.8}Sr_{0.2}TiO_3$
10) Electrodeposition of Ni.

11) Ceramic synthesis of PZT.
12) Antocombustionsyrthesis of $Cofe_2O_4$.

SCP 3.1

1) Faraday Effect.
2) Kerr Effect.
3) Pockel Effect.
4) Electrical conductivity measurement and determination of activation energy.
5) Thermoelectric power measurement.
6) Determination of curie temperature.
7) Particle size estimation.

_____xxxx_____xxxx_____

M.Sc-I, SEME. I, PHYSICS (CONDENSED MATTER PHYSICS)
HCT - 1.1: MATHEMATICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-21)

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:

15. Introduction to Mathematical Physics by C. Harpcr, Prcnticc - Hall of India Ltd. N.Delhi 1993,(Chapters 2,4,6,9)
16. Mathematical Physics by A.G. Ghatak, I.C.Goyal and S.J.Chua, McMillan India Ltd. New Delhi 1995 (Chapters 4,7,9,10)
17. Matrices and Tensors for Physicists,by A W Joshi
18. Advanced Engineering Mathematics, by E Keryszig
19. Mathematical Method for Physicits and Engineers, by K F Reily, M P Hobson and S J Bence
20. Mathematics for Physicists by Mary L B
21. Mathematical Methods for Physics, by G Arfken

M.Sc-I, SEME. I, PHYSICS (CONDENSED MATTER PHYSICS)
HCT - 1.2: SOLID STATE PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Crystal Structure (15)

Basic Structures, Bravais systems in 2D and 3D, Bonding in solids, Reciprocal Lattice, Diffraction by X-ray and structure factor, Point defects and dislocations,
Specific Heat: Lattice vibration, Phonons, Einstein and Debye's theories.

Unit II: Energy bands and Semiconductors (20)

Energy bands:
Metal, Insulator and Semiconductor, Bloch theorem, Electron in periodic potential -1D, Tight and loose band approach, Brillion's Zones, Fermi surfaces.
Semiconductors:
Direct and indirect band gap semiconductors, Effective mass, Hall effect and thermoelectric power, Intrinsic and Extrinsic carrier concentration.

Unit III: Dielectrics (10)

Electronic, Ionic, Orientational polarizations, Clausius-Mossotti equation, Dipole theory of ferroelectricity, Internal field in solids, Classification of magnetic materials,

Unit IV: Superconductors (15)

Basic concept, Meissner effect, Types I and II, Thermal properties of superconductor, Thermodynamics of superconductors, London equation, Josephson tunneling and its theory, BCS theory.

Reference Books:

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

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

13) Solid State Physics S.O.Pillai (New age international limited Publications)

14) Solid State Physics by Saxena and Gupta(Pragati Editions)

15) Solid State Physics by Rita John (Mc Graw Hill)

M.Sc-I, SEME. I, PHYSICS (CONDENSED MATTER PHYSICS)
HCT - 1.3: ANALOG & DIGITAL ELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 Feedback, Effect of feedback 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,

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, Multiplexers and Demultiplexers

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 /Subtraction, 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 2020-2021)

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:

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

M.Sc-I, SEME. I, PHYSICS (CONDENSED MATTER PHYSICS)
SCT– 1.2 (CMP): ENERGY STUDIES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I: Indian Energy Scenario (15)

Role of energy in economic development and social transformation, Energy and gross Domestic product (GDP), Gross National Product (GNP) and its dynamics.
Various types of energy sources: Energy sources and overall energy demand,
Availability of energy sources, Energy consumption in various sectors and its changing pattern, projected energy demands. Non Renewable Energy sources : Coal, Oil, Natural gas, Nuclear power, Hydroelectricity, Renewable Energy sources: Solar ,Wind, Biomass, Tidal, Ocean wave, Ocean thermal, Geothermal and other , Depletion of energy sources and impact of exponential rise in energy consumption on economics of India and on international relations.
Energy Security: Energy for security and security of energy, Energy consumption and its impact on environmental climatic change.
Future Energy Option: Sustainable development, Energy crisis, Transition from carbon free technologies, Parameters of transition, Carbon credits.

Unit-II: Solar Radiation and Its Measurements (15)

Importance of Solar Energy: Nature of solar radiation, Sun as a fusion rector, special distribution of extra-terrestrial radiation, Estimation of extra-terrestrial solar radiation, Radiation on horizontal and titled surfaces, Beam, diffuse, global radiation and their Measurement.
Available solar radiation, Measurement of beam, diffuse, global radiation,
Pyranomater, Pyrhelimeter, Sunshine duration recorder Angstrom relation. Ref. no. 8

Unit-III : Basics of Heat transfer (15)

Heat and Thermodynamics: Basic units, dimensions, Concept of heat, energy and work, Ideal gas flow, 1st and 2nd law of thermodynamics, Types of heat transfer.
Conductive heat transfer: Fourier's law. Stefans-Boltzman relation and IR heat transfer between gray surfaces.
Radiative heat transfer: sky radiation, radiation heat transfer coefficient
Convective heat transfer: Natural and forced convection, natural convection between parallel plates, Non-dimensional numbers, conductive heat transfer coefficient, Heat transfer due to wind. Ref. no. 9

Unit-IV : Energy Storage (15)

Types of energy storage systems : sensible and latent heat storage systems, Electric energy storage systems, Chemical energy storage systems, Heat exchanges,
Hydrostorage, solar pond as a energy storage, Green house. Ref.no. 11

Reference Books:

1. TEDDY Year Book, (Tata Energy Research Institute (TERI) Publication, New Delhi).
2. World Energy Resources, Charles E.Brown (Springer Publication), 2002.
3. Energy Policy for India, B.V. Desai (Welley Eastern Publication)
4. Handbooks of Solar Radiation, A.Mani (Allied Publishers), 1980.
5. Solar Energy Fundamentals and Applications, H.P. Garg and Satya Prakash, (Tata McGraw Hill), 1977.
6. Treatise on Solar energy, H.P. Garg, Volume 1,2 and 3.(John Wiley and Sons) 1982
7. Principles of Solar Engineering, F.Kreith and J.F. Kreider, McGraw Hill , 1978
8. Solar Energy Thermal Processes, J.A. Duffie and W.A. Beckman, (John Wiley and Sons) 1980
9. Heat and Thermodynamics, M.W. Zemansky,(McGraw Hill Publication)
10. Principles of Solar Energy Conversion, A.W.Culp (McGraw Hill Publication)
11. Solar Energy Principles of Thermal Collection and Storage, S.P. Sukhatme, 2nd edition (Tata McGraw Hill Publication C.Ltd.(, 1976
12. Solar Energy Utilization, G.D.Rai (Khanna Publishers) 1996
13. Solar Thermal Engineering, J.A. Duffie(Academic Press)
14. Renewable Energy Sources and Conversion Technology, N.K. Basal, M. Kleeman and S.N. Srinivas ,(Tata Energy Reserch Institute, New Delhi) 1996

M.Sc-I, SEME. II, PHYSICS ((CONDENSED MATTER PHYSICS)
HCT - 2.1: QUANTUM MECHANICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 HartreeFockself 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:

7. Introductory Quantum Chemisty (3rd Ed^{n}), A. K. Chandra (Tata McGraw Hill).
8. Quantum Chemistry (4th Edition) - Ira N. Levine (Prentice Hall) of India Pvt. Ltd. New Delhi. 1995.
9. 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 2020-2021)

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: STATISTICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Statistical Thermodynamics: (20)

10. Thermodynamic systems and equilibria, Laws of thermodynamics and their consequences, Nernst heat theorem, Microstates and microstates, Postulate of equal priori probability, Probability calculations, Thermodynamic potentials and Maxwell's relations, Chemical potential, phase equilibria, Black Body radiation and planks distribution, Phase equilibria, Free energy and its connection with thermodynamic quantities, entropy of mixing and Gibbs and paradox.

11.

12. Unit II: Classical statistical mechanics: (15)

13. Statistical ensembles, Microcanonical ensemble- system in contact with heat revisor, Condition for thermal equilibrium, canonical ensemble – molecular ideal gas and grand canonical ensemble, Liouville's theorem, Ensembles, Maxwell Boltzmann distribution, classical ideal gas,

14.

15. **Unit III: Quantum Statistical Mechanics (15)** Phase space (Diagram of an oscillator), Maxwell- Boltzmann statistics, Fermi-Dirac statistics and Bose- Einstein statistics, Liouville's theorem, Ideal Bose gas, Ideal Fermi gas- weekly and strongly degerate , Bose- Einstein condensation.

16.

17. Unit IV: Phase transitions and critical phenomena (10) Phase transition, Triple Point, Condition for phase equilibrium, First order phase transition, Ehrenfests equations, Clausius- Clayperon equation, Second latent heat equation, Examples, Second order phase transition, Critical indices, The law of corresponding states.

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
4) Text Book of statistical mechanics. Suresh Chandra, CBS Publications
5) Elementary Statistical Mechanics Gupta, Kumar, Pragati Prakashan.

M.Sc-I, SEME. II, PHYSICS (CONDENSED MATTER PHYSICS)
SCT - 2.2: Electronic Instrumentation
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Transducers (15)

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 (15)

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 (15)

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 (15)

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-I, SEME. II, PHYSICS (CONDENSED MATTER PHYSICS)
OET - 2.1: FUNDAMENTALS OF ELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

UNIT 1 : Electronic Components (15)

Circuit concept Units, Standards and Dimensions. Electric current, Electric charge, potential difference, Electric power and Energy. Circuit elements : Passive elements and active elements. Network Law's, Junction Law's (KCL), Mesh Law's (KVL) Application of Network Law's to simple dc networks theorems – Thevenin's theorem, Norton's theorem Max power transfer theorem.

UNIT 2 : Semiconductor Devices (15)

Junction Diodes, p-n junction, an unbiased p-n junction, a biased p-n junction and V-I characteristics of p-n junction. Some special P-N junction: - Photodiodes, LED and Solar Cell. Junction transistor, Transistor static characteristic Self-bias or emitter bias, Two-port representation of Transistor (hybrid parameter) JFET: Static Characteristic of FET comparison of FET with Bipolar transistor.

UNIT 3: Applications of Active & Passive (15)
Operational Amplifier Characteristics and Applications

Introduction, Ideal Op-Amp, DC and AC Characteristics: Instrumentation Amplifier, V to I and I-V converter Precision rectifier, Differentiator and Integrator. Comparator Schmitt trigger wave generators (Square wave and Triangular wave) and first order Low pass and High pass filters.

UNIT 4: Special IC series (15)

Op-Amp regulator, Design of power supplies using voltage regulator ICs, 555 Timer as Monostable and Astable operation.

Reference books:

11. D Chattopadhyaya, P.C. Rakshit, B Saha and N NPurkait: Foundations of Electronics, New Age International Edition.
12. D. Roy Choudhary and ShailJain : Linear Integrated Circuit, New Age International (P) Ltd.
13. P-Amp and Linear Integrated Circuits : R. A. Gaikwad, PHI of India Ltd.
14. A Texbook of Electronics (Second Edition) : S. L. Kakani and K. C. Bhandari
15. Electronic Principles : A. P. Malvino, TMH Edition.

M.Sc-I, SEME. II, PHYSICS (CONDENSED MATTER PHYSICS)
OET - 2.2: Nuclear Techniques
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I : Interaction of radiation with matter (15)

General description of interaction processes, interactions of directly ionizing radiation (electrons, protons and ions), stopping power, linear energy transfer, range of particles, straggling, interaction of indirectly ionizing radiation (gamma radiations), attenuation coefficient, energy transfer, build up factor.

Unit-II: Nuclear detectors (15)

Ionization and transport phenomena in gases, cylindrical and multiwire proportional counters, Ionization chamber, Proportional counter, GM counter, general characteristics of organic and inorganic scintillators, scintillation detectors NaI-(Tl), detection efficiency for various types of radiations, scintillators, detection efficiency for various types of radiation, photomultiplier gain, semiconductor detectors, surface barrier detector, Si(Li), Gel(Li), HPGe detectors.

Unit-III: Pulse processing and related electronics (15)

Preamplifier, pulse shaping and pulse stretchers networks, delay lines, amplifier, Pulse height analysis and coincidence technique, Discriminators: Single channel analyzer, multichannel analyzer, pulse height spectroscopy, pulse shape discrimination, coincidence and anti- coincidence units.

Unit-IV: Dosimetry and radiation protection (15)

Units Rontgen, RAD, REM, RBE, BED, Gray, Sievert, kerma, Cema, energy deposit and energy imparted, absorbed dose, main aims of radiation protection, dose equivalent and quality factor, organ dose, effective dose equivalent effects and dose limits, assessment of exposure from natural man-made sources, effects of radiation on human body.

Books:

1. Nuclear radiation detectors, S. S. Kappor and V. S. Rmanurthy. (Wiley Eastern Limited, New Delhi,) 1986.
2. Introduction to radiation protection dosimetry, J. Sabol and P. S. Weng, (World Scientific), 1995.
3. Techniques for nuclear and particle physics, W. R. Len (Springer), 1955.
4. Nuclear Measurement Techniques, K. Sriram, (Affiliated East-West Press, New Delhi), 1986.
5. Fundamentals of surface and thin film analysis, Leonard C. Feldman and James W. Mayer, (North Holland, New York), 1988.
6. Introduction to nuclear science and technology, K. Sriram and Y. R. Waghamare, (A. M. Wheeler), 1991.
7. Nuclear radiation detection, W. J. Price, (McGraw-Hill, New York), 1964.
8. Alphas, beta and gamma-ray spectroscopy,. K. Siegbahn, (North Holland, Amsterdam), 1965.
09. Introduction to experimental nuclear physics, R. M. Singru, (John Wiley and Sons),

1974.
10. Radioactive isotopes in biological research, Willaim R. Hendee, (John Wiley and Sons), 1973.
11. Atomic and Nuclear physics, Satendra Sharma, Pearson Education, 2008

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

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 (CONDENSED MATTER PHYSICS)
HCT - 3.2: ATOMIC and MOLECULAR PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 (CONDENSED MATTER PHYSICS)
HCT - 3.1: SOFT CONDENSED MATTER PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I Energy bands in solids (15)

The basic Hamiltonian in solid, Reduction to one electron problem for determining bands in solids (single particle approximation) - variational principle, Hartree approximation, Hartee-Fock approximation, Density functional approximation-Comparison with conventional wave function approach, Hohenberg-Kohn Theorem; Kohn-Sham Equation; Thomas-Fermi approximation and beyond; Practical DFT in a many body calculation and its reliability.

Unit-II Magnetism (15)

Origin of magnetism, quantum theory of diamagnetism, Landau diamagnetism,
Paramagnetism: Classical and quantum theory, magnetism in rare-earth and iron group atoms, quenching of orbital angular momentum, Van-Vleck Paramagnetism and Pauli Paramagnetism, Ferromagnetism: Cuire Weiss Law, temperature dependence of magnetization, Heisenberg exchange interaction, Ferromagnetic domains, Magnetic domains – exchange energy, magnetostatic energy, wall energy, magnetostrictive energy, Neel and Bloch wall, the Bloch T3/2 law, Neel model of antiferromagnetism and ferrimagnetism. Magnetic anisotropy and magnetostatic interactions- Direct, exchange, indirect exchange and itinerant exchange, (double exchange and RKKY interactions). Spin waves in ferromagnets - magnons, Spin waves in lattices –
ferri and antiferromagnetism, Measurement of magnon spectrum. Magnetic resonance and crystal field theory, Jahn-Teller effect; Hund's rule and rare earth ions in solids. Pinning effects, The Kondo effect, spin glass, solitons, Magneto resistance – spin valves and spin switches, giant magneto resistance (GMR), spintronics.

Unit-III Dielectrics and Ionics: Dielectric properties in solid – polarization, electrical conduction, dielectric loss, breakdown of dialectics, nonlinear dielectrics – ferroelectrics, junction capacitor, piezoelectric, electrets , impedance spectroscopy, complex dielectrics, eclectic modulus. Ionic conduction in solid: defect in solid, conduction mechanism, Nernst Einstein equation, cataonic, protonic and anionic conductor, temperature and frequency dependent of conductivity, hopping mechanism, universal power law (Jonscher's Power Law) oxygen ion conductor, solid electrolyte, fuel cell, SOFC.

Unit-IV Polymers, Composites and Soft matters (15)

Polymer and their classification, Molecular weight, degree of polymerization, techniques of polymerization, crystallinity of polymers, applications of polymers. Polymer electrolyte, conducting polymers- concept of solitons, polarons, biolarons, Doping in conducting polymers, Common conducting polymers, Properties and applications of conducting polymers: PLED, sensors actuators.
Composite Materials- various types of composites, microcomposites and mactrocomposites, fibre composites, and matrix materials, Different kinds of soft

matters, Symmetry and order parameters, Dispersion colloids, liquid crystal, biological membranes, macromolecules- DNA condensation, bilayer,
Marcelja's molecular field theory mesosphere.

Recommended Books:

1) The Modern Theory of Solids- F.Sitz
2) Solid State Theory-W. Harrison, TMH,
3) Introduction to Solid State Physics by C. Kittel.
4) Solid State Physics – A.J. Dekker.
5) Introduction to Solid State Physics – H.P. Myers.
6) Solid state Physics – N.N. Ashcroft and N.D. Mermin.

M.Sc-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
SCT – 3.2: THIN FILM PHYSICS AND TECHNOLOGY
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit - I Chemical Methods of Thin films synthesis (15)

Chemical vapor deposition: Common CVD reactions, Methods of film preparation, laser CVD, Photochemical CVD, Plasma enhanced CVD. Chemical bath deposition: ionic and solubility products, preparation of binary semiconductors, Electrodeposition: Deposition mechanism and preparation of compound thin film Spray pyrolysis: Deposition mechanism and preparation of compound thin Films.Ion-assisted deposition (IAD), Laser ablation, Longmuir Blochet film, Sol-gel film deposition.

Unit -II Physical Methods of Thin Film Synthesis (15)

. Introduction to Thin Films, Thermal evaporation methods: Resistive heating, Flash evaporation, Laser evaporation, Electron bombardment heating, Arc evaporation, Sputtering process: Glow discharge, DC sputtering, Radio frequency sputtering, Magnetron sputtering, Ion beam sputtering.

Unit -III Physics of Surfaces, Interfaces and Thin films (15)

Mechanism of thin film formation: Formation stages of thin films, Condensation and nucleation, Thermodynamic theory of nucleation, Growth and coalescence of islands, Influence of various factors on final structure of thin films, Crystallographic structure of thin films. Properties of thin films: Conductivity of metal films, Electrical properties of semiconductor thin films, Transport in dielectric thin films, Dielectric properties of thin films, Optical properties of thin films. Thin films of high temperature superconductors, Diamond like carbon thin films

Unit -IV Thin films for Devices & other Applications (15)

Dielectric deposition- silicon dioxide, silicon nitride, silicon oxynitride, polysilicon deposition, metallization, electromigration, silicides. Thin film transistors, thin film multilayers, optical filters, mirrors, sensors and detectors.

References:

1. LudmilaEckertova, Physics of thin films, 2nd Revised edition, Plenum Press, New York, 1986 (Reprinted 1990),

2. K.L. Chopra, Thin film phenomena, Mc-Graw Hill, New York, 1969.

3. L. C. Feldman and J.W. Mayer, Fundamentals of surface and Thin Films Analysis, North Holland, Amsterdam, 1986.

4. S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley,1985.

Additional References:

1. R.W. Berry, P.M.Hall and M.T. Harris, Thin film technology, Van Nostrand, New Jersey, 1970, K.L.Chopra and LK.Malhotra (ed),

2. Thin Film Technology and Applications, T.M.H. Publishing Co., New Delhi (1984).

M.Sc-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
OET - 3.1: MEDICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I: Forces acting on body and Physics of the skeleton (15)
Statics, Frictional forces, Dynamics, Conservation of Energy in the body, Heat losses from body, Pressure in the body. Physical properties of bone, Mechanics of joints,

Unit-II: Electricity within the body (15)
Nervous system and neuron, Electric properties of Nerve, Electrical potential of nerve, Nernst Equation, Bio potentials EMG, ECG, EEG, EOG, ERG, Magnetic signals from heart and Brain

Unit-III: Physics of hearing (15)
Basic definition of Audibility, Physics of ear, Human Audibility Curve, Sensitivity of ear, Testing of hearing. Deafness and hearing aids, Sound in medicine, Sound pollution, Effects of sound pollution on living body, Methods to minimize sound pollution.

Unit-IV: Physics of vision (15)
Optics of eye, Diffraction effects of eye, Refractive effect in eye and its correction, Contact Lenses, Color vision and chromatic aberration, Instruments used in Ophthalmology.

Reference Books:

1. Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons,Inter.Publ.
2 .Essential of Biophysics by Narayanan, New age Publication.
3. Radiation Biophysics by Edward Alphan, prentice Hall Advance Referes.
4. T.B. of Biophysics by R.N. Roy , Central Publication.
5. Medical Informatics by Smita Mishra and K. C. Mishra, ICFAI university.
6. Fundamental of Bioinformatics by Harisha. S.
7. Biomedical Engineering by S.N. Sarbadhikari, University press.
8. Principles of medical electronics &Biomedicalinstrumentation by c. Raja Rao, S. K. Guha , University press.
9. Electronics in medicine & Biomedical instrumentation by NandiniJog ,
10. Websites of the related topics

M.Sc-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
OET - 3.2: ENERGY HARVESTING DEVICES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit -1: Solar Cells (15)

Photovoltaic effect, Solar cell characterization, Types of Solar cells, Solid state solar cells Silicon solar cell, CdTe based solar cells, CdS/Cu_2S solar cells, $CuInSe_2$ based solar cells, Metal-semiconductor solar cells, photoelectrochemical and photo electrolysis cells, Solar cells based on thin film heterojunctions, Ultra thin absorber solar cells, Nanostructured solar cells, Dye sensitised solar cells: basic concepts, working and materials. Organic Solar cells: basic concepts, working and materials.

Unit -2: Super Capacitors (15)

Comparison of battery and super capacitors, Super capacitor characterization, Types of super capacitors, double layer and pseudo capacitance, hybrid super capacitors, Recent status of carbon, RuO_2 and polyaniline based super capacitors, different methods for preparation of cathodic and anodic electrode materials, Fabrication of super capacitors with examples, Applications of supercapacitors

Unit -3: Fuel Cells (15)

Comparison between fuel cells and batteries, fuel cell characterizations, Types of fuel cells: Metal oxide, proton exchange membrane, Phosphoric acid, Solid oxide fuel cells, working of fuel cells, Materials for fuel cells, applications of fuel cells

Unit -4: Piezoelectrics (15)

Piezoelectric Energy Harvesting: Energy harvesting basis, case study
Piezoelectric Materials: Piezoelectric polycrystalline ceramics,Piezoelectric Single Crystal Materials, Piezoelectric and Electrostrictive Polymers, Piezoelectric Thin Films. Piezoelectric transducers, Mechanical energy harvester using Laser Micromachining, Mechanical energy harvester using PlezoelectricFibers, Piezoelectric Microcantilevers, Energy harvesting circuits, Multimadal energy harvesting, Mangetoelectric composites, Introduction to Piezoelectric bulk Power generators, Piezoelectric Micro Power Generators, Conversion efficiency, Power storage circuits

Reference Books

1. Semiconductor Sensors, S M Sze, A Wiley- Interscience Publication, John Wiley and Sons, NY1994
2. Electrochemical Supercapacitors, B E Conway, Kluwer Academic/ Plenum publishers, NY 1999.
3. C. N. R. Rao and Claudy Rayan Serrao, J. Mater. Chem., 2007, 17, 4931–4938
4. Solar Cells by Martin Green.
5. Photoelectrochemical Solar Cells by S. Chandra, Gordon &Breach Science Publisher, UK
6. Energy Harvesting Technologies, ShashankPriya, Daniel J. Inman Springer

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

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:

10. D.A. Roustan: Bipolar Semiconductor Devices.
11. Mauro Zambuto: Semiconductor Devices.
12. D. Nagchoudhari: Semiconductor Devices.
13. Karl Hess: Advanced theory of semiconductors devices.
14. S. M. Sze: Physics of Semiconductor Devices 2nd edition..
15. A Dir - Bar - Lev: Semiconductor and Electronic Devices.
16. M. H. Rashid: Power Electronics.

17. P. C. Sen: Power electronics
18. B. G. Streetman and S. Banergee : Solid state Electronic Devices

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

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 (CONDENSED MATTER PHYSICS)
HCT - 4.3: PROPERTIES OF SOLIDS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit - I Optical and Dielectric properties (15)

Maxwell's equations and the dielectric function, Lorentz oscillator, the Local field and the frequency dependence of the dielectric constant, Polarization catastrophe, Ferroelectrics Absorption and Dispersion, Kraemers' Kronig relations and sum rules, single electron excitations and plasmons in simple metals, Reflectivity and photoemission in metals and semiconductors Interband transitions and introduction to excitons, Infrared spectroscopy.

Unit -II Transport Properties (15)

Motion of electrons and effective mass, The Boltzmann equation and relaxation time, Electrical conductivity of metals and alloys, Mathiessen's rule, Thermo-electric effects, Wiedmann-Franz Law, Lorentz number, ac conductivity, Galvanomagnetic effects.

Unit -III Magnetism and Magnetic materials (15)

Review: Basic concepts and units, basic types of magnetic order Origin of atomic moments, Heisenberg exchange interaction, Localized and itinerant electron magnetism, Stoner criterion for ferromagnetism, Indirect exchange mechanism: superexchange and RKKY.

Magnetic phase transition: Introduction to Ising Model and results based on Mean field theory, Other types of magnetic order: superparamagnetism, helimagnetism, metamagnetism, spinglasses.

Magnetic phenomena: Hysteresis, Magnetostriction, Magnetoresistance, Magnetocaloric and magneto-optic effect.

Magnetic Materials: Soft and hard magnets, permanent magnets, media for magnetic recording.

Unit -IV Superconductivity (15)

The phenomenon of superconductivity: Perfect conductivity and Meissner effect.

Electrodynamics of superconductivity: London's equations, Thermodynamics of the superconducting phase transition: Free energy, entropy and specific heat jump.

Ginzburg-Landau theory of superconductivity: GL equations, GL parameter and classification into Type I and Type II superconductors, The mixed state of superconductors.

Microscopic theory: The Cooper problem, The BCS Hamiltonian, BCS ground state

Josephson effect: dc and ac effects, Quantum interference.

Superconducting materials and applications: Conventional and High Tc superconductors, superconducting magnets and transmission lines, SQUIDs.

Assignments: should be based on numerical problems related to the syllabus.

Main References:

1. 1. Solid State Physics, H. Ibach and H. Luth, *Springer(Berlin)* 2003 (IL)
2. Solid State Physics, Neil Ashcroft and David Mermin (AM)
3. Introduction to Solid State Physics (7th/ 8th ed) Charles Kittel (K)
4. Principles of Condensed Matter Physics, Chaikin and Lubensky (CL)

Additional References:

1. Principles of Condensed Matter Physics, Chaikin and Lubensky (CL)
2. Intermediate theory of Solids, Alexander Animalu (AA)
3. Optical Properties of Solids, Frederick Wooten, Ac Press (New York) 1972 (FW)
4. Electrons and Phonons, J M Ziman, Electron transport in metals, J.L. Olsen
5. Physics of Magnetism and Magnetic Materials, K.H.J. Buschow and F.R. de Boer Introduction to Magnetism and Magnetic Materials
6. Magnetism and Magnetic Materials, B. D. Cullity
7 Solid State Magnetism, J. Crangle
8 Magnetism in Solids, D. H. Martin

M.SC-II, SEME. IV, PHYSICS (CONDENSED MATTER PHYSICS)
SCT - 4.1: EXPERIMENTAL TECHNIQUES IN PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I Electronic instrumentations (15)

Measurement system- mechanical and electrical, Transducers and its types, sensors, differential output transducer, LVDT, Hygrometers, Measurement of thermal Conductivity (gas analyzer), Physiological transducers Bio-potential electrodes. Digital and analog measuring instruments – voltmeter, ammeter, oscilloscope, power meter, LCR meter, instrumentation amplifier, filtering and noise reduction in instruments, shielding and grounding, lock-in detector, box-car integrator, interfacing sensors and data acquisition, Integrated circuits technology – fabrications, Power supplies- primary and secondary cell, regulated power supply, SMPS, UPS, Step down switching regulator, Inverters- voltage driven inversion, current driven inversion.

Unit-II Lasers and Optoelectronic instrumentation (15)

Lasers: - Temporal and special coherence, Einstein coefficients, The threshold condition, two, three and four level laser systems, Modes of a rectangular cavity and open planar resonator, Quality factor, mode selection, The Ruby laser, The Helium-Neon laser, the carbon dioxide (CO2)laser. Optoelectronic devices : Photoconductivity, LDR, photodiode, phototransistor, solar cell, metal semiconductor detector, LCD, CCD , LED, Laser diode, PIN photodiode, Avalanche photodiode, Heterojunction photodiode, Organic light emitting diodes,. Optical fiber- ray propagation Step –index and graded-index fibers, dispersion and attenuation in fiber optics, Dispersion compensation mechanism, Erbium-doped fiber amplifiers, Optoelectronic modulators.

Unit III (a). X-ray analysis (15)

Origin of X-rays, X-ray generators. Scattering of X-ray, atomic scattering factor, Diffraction of X-ray, various X-ray diffraction methods, X-ray powder diffraction method -indexing of powder lines, Laue's method, rotational/oscillation method, X-ray diffractormeter, determination of crystal structure and lattice parameter, small angle x-ray diffraction and its applications. XPS, XRF and its applications.

(b).Low pressure and Low temperature: Production of low pressure -Rotary, oil diffusion, turbo molecular, getter and cryo pumps; gauges – Macleod thermoelectric (thermocouple, thermistor and pirani), penning, hot cathode partial pressure measurement; leak detection; gas flow through pipes and apertures; effective pump speed; vacuum components. Production of Low temperature**:** Gas liquifiers; Cryo -fluid baths; liquid He cryostat design; closed cycle He refrigerator; low temperature measurement.

Unit-I Analytical Instrument (15)

Electron Microscopy (SEM, TEM, HRTEM), Scanning probe microscopy (AFM, MFM, STM), UV-Vis, spectroscopy and its applications. FT-IR spectroscopy, Luminescence spectroscopy techniques- Fluorescence spectroscopy, Raman spectroscopy, Thermal analysis using DTA, TGA, DSC; Electronic transport analysis using Current vs Voltage characteristics – two probe and four probe techniques - various types of contacts, Dielectric and impedance spectroscopy, spectrum analyzer, fluorescence and Raman spectrometer, Interferometers for different analytical study.

Recommended Books:

1) Electronic Instrumentation - Kalsi H S

2) X-Ray Crystallography – B.E. Warren.
3) Materials Characterization: Introduction to Microscopic and Spectroscopic Methods,
4) Materials Characterization Techniques Sam Zhang, Lin Li, Ashok Kumar

M.Sc-II, SEME. IV, PHYSICS (CONDENDED MATTER PHYSICS)
SCT - 4.2: PHYSICS OF NANO MATERIALS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Introduction (15)

Background of Nanoscience and Nanotechnology, Definition of Nanoscience and Nanotechnology, Possible Applications of Nanotechnology, Top-down and Bottom-up approach (Brief).

Band Structure and Density of States at Nanoscale: Introduction, Energy Bands, Density of States at Low - dimensional Structures, Quantum confinement – semiconductors, quantum wells, quantum wires, quantum dots, quantum rings. Manifestation of quantum confinement, quantum confinement effect, dielectric quantum confinement, effective mass approximation, core-shell quantum dots.

Unit II: Properties of Nanomaterials (15)

Optical properties: Absorption, transmission, Beer-Lamberts law (derivation), Photoluminscence, Fluorescence, Phosphorescence,Cathodoluminscence, Electroluminescence, Surface Plasmon resonance (SPR), effect of size of nanoparticles (metal, semiconductor) on absorption and SPR spectra.

Electrical transport: Electrical Conduction in Metals, Classical Theory - The Drude Model Quantum Theory - The Free Electron Model Conduction in Insulators/Ionic Crystals, Electron Transport in Semiconductors, Various Conduction Mechanisms in 3D (Bulk), 2D(Thin Film) and Low – dimensional Systems**,** Thermionic Emission Field – enhanced Thermionic Emission (Schottky Effect), Field - assisted Thermionic Emission from Traps (Poole - Frenkel Effect), Hopping Conduction, Polaron Conduction.

Unit III: Growth Techniques and Characterization Tools of Nanomaterials (20)

Growth techniques: Introduction, Top - down vs. Bottom - up Technique, Lithographic Process and its limitations , Nonlithorgraphic Techniques ,Plasma Arc Discharge Sputtering ,Evaporation, Chemical Vapour Deposition ,Pulsed Laser Deposition ,Molecular Beam Epitaxy, Sol - Gel Technique , Electrodeposition , Different chemical routes, Other Processes.

Characterization Tools of Nanomaterials: Scanning Probe Microscopy (SPM): Introduction, Basic Principles of SPM Techniques, The Details of scanning Tunneling Mocroscope (STM), General Concept and Definite Characteristics of AFM, Scanned - Proximity Probe Microscopes Laser Beam Deflection, AFM Cantilevers ,Piezoceramics, Feedback Loop Alternative Imaging Modes. Electron Microscopy: Introduction, Resolution vs. Magnification Scanning Electron Microscope SEM Techniques, Electron Gun Specimen Interactions Environmental SEM (FESEM), Transmission Electron Microscope, High Resolution TEM Contrast Transfer Function. Near-field scanning optical microscopy (SNOM/NSOM), UV-Vis single and dual beam spectrophotometer, photoluminescence spectrometer, X-ray diffractometer. Surface area and Pore size measurements (BET analysis)

Unit IV: Some Special Topics in Nanotechnology (10)

Introduction ,The Era of New Nanostructure of Carbon Buckminsterfullerene, Carbon Nanotubes, Nanodiamond, BN Nanotubes Nanoelectronics ,Single Electron Transistor, Molecular Machine, Nano-biometrics.

Reference Books:

8) **Introduction to Nanoscience and Nanotechnology:** K.K. Chattopadhyay and A.N. Banerjee, PHI Publisher
9) **Nanoscience and Technology:** V. S. Murlidharan, A. Subramanum.
10) **Nanotubes and Nanofibers:** YuryGogotsi
11) **A Handbook of Nanotechnology :** A. G. Brecket
12) **Instrumentations and Nanostructures:** A. S. Bhatia
13) **Nanotechnology: Nanostructures and Nanomaterials** - M. B. Rao
14) **Nanotechnology-Principles and practices** - S. K. Kulkurni (Capital Publication Company)

Reference Books:

1) Handbook ofApplied Solid State Spectroscopy, D. R. Vij, Springer
2) Phtoelectron and Auger Spectroscopy,T.A.Carlson, Plenum Press , 1975
3) Practical Guide to Surface Science and Spectroscopy,Yip-WahChung,Academic Press
4) Fundamebntal of Molecular Spectroscopy, C.N.Banwell,TataMc-Graw Hill.

M.SC-, PHYSICS (CONDENSED MATTER PHYSICS)
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Practical List

HCP 1.1/1.2/1.3

25) Determination Band gap of Ge Diode.
26) Crystal Structure FCC type.
27) Temp. Variation of Breakdown voltage of zerer diode.
28) Temperature Transducer (Thermister).
29) P.N. Junction capacitance.
30) LVDT.
31) Photovoltaic cell.
32) Hall Effect.
33) CC with CC Amplifier.
34) DC Amplifier.
35) Voltage Regulator
36) Astablenultivibrator (using IC741Op Amp)
37) Op-Amp Phase Lead Circuit.
38) Op-Amp Phase Lag circuit.
39) Verificaiton of De Morgans theorem.
40) Wein Bridge Oscillator.
41) Op-Amp Phase shift Oscillator.
42) Negative feedback Amplifier.
43) D.T.L. gates.
44) Study of filters.
45) Transistor Biasing.
46) CE amplifier Desing.
47) FET characteristics and Designing of Amplifier.
48) Divide by 2 Divide by 5 & Divide by 10 counter using IC-7490.

SCP 1.1/1.2

7) Op-Amp (Adder, Subtractor, Integratorc, Differentiator).
8) Op-Amp I to V, V to I converter.
9) Voltage source.
10) Constant current source (floating load).
11) Constant current source (Grounded load).
12) Variable duty cycle MV using Op-Amp.

HCP 2.1/2.2

11) Wave form generator (square & triangular)
12) Twin T network.
13) Bear Lamberts law
14) Resistivity by four probe method.
15) Strain gauge I.
16) Lattice prarameter&particlesiretestimation.
17) Op-Amp instrumentation amplifier IC324.
18) Characteristics of UJT.
19) Electrodepositon of Mn.
20) Op-Amp. Parameters.

SCP 2.1/2.2

7) Study of thermocouple &thermister.
8) Intensity calculation.
9) Crystal structure I.
10) Crystal structure II.
11) Study of phase diagram.
12) Hall Effect II.

OEP 2.1/2.2

25) Transister Parameters.
26) Op-Amp inverting and non-inverting amplifiers.
27) Monostablemultivibratorvsing IC555.
28) FET charaterishes.
29) Op-Amp Adder.
30) Op-Amp subtractor.
31) First order High pass filter.
32) First order Low pass filter.
33) Determination of optical gap.
34) Determination of optical absorption by materials & hence determination of type of transition.
35) Study of p.n. junction photo voltaic.
36) Characterization of a PV cell in dark & in light & hence determination of junction ideality factor.

HCP 3.1/3.2

13) Susceptibility measurement of $FeCl_3 6H_2O$ solution.
14) Successive Ionic Layer Adsorption and Reaction.
15) Chemical Bath deposition of PbS.
16) Chemical Bath deposition of CdS.
17) Strain gauge II.
18) Optical studies on CdS thin film (α vs λ, determination of E_g and m).
19) LVDT II.
20) Band gap determination using four probe method.
21) Hydroxide co-precipitation of $Ba_{0.8}Sr_{0.2}TiO_3$
22) Electrodeposition of Ni.
23) Ceramic synthesis of PZT.
24) Antocombustionsyrthesis of $Cofe_2O_4$.

SCP 3.1

8) Faraday Effect.
9) Kerr Effect.
10) Pockel Effect.
11) Electrical conductivity measurement and determination of activation energy.
12) Thermoelectric power measurement.
13) Determination of curie temperature.
14) Particle size estimation.

_____xxxx_____xxxx_____

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
School of Physical Sciences
M.Sc. Physics Choice Based Credit System (CBCS)
Course Structure

M.Sc. Part-II Physics (Condensed Matter Physics) w.e.f. 2020-21

M.Sc. PHYSICS SEMESTER-III								
Paper Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 3.1	Semiconductor Devices	70	30	100	4	--	--	4
HCT 3.2	Atomic, Molecular & Nuclear Physics	70	30	100	4	--	--	4
	Soft Core-Theory (Any one)							
SCT 3.1	Soft Condensed Matter Physics	70	30	100	4	--	--	4
SCT 3.2	Thin Film Physics & Technology							
Open Elective-Theory (Any one)								
OET3.1	Medical Physics	70	30	100	4	--	--	4
OET3.2	Energy Harvesting Devices							
	Practical							
HCP3.1	Practical-9: (Based on HCT 3.1)	35	15	50	--	2	--	2
HCP3.2	Practical-10: (Based on HCT 3.2)	35	15	50	--	2	--	2
SCP3.1/ 3.2	Practical-11: (Based on SCT 3.1/3.2)	35	15	50	--	2	--	2
OET3.1/ 3.2	Practical-12: (Based on OET 3.1/3.2)	35	15	50	--	2	--	2
	Seminar / Tutorial	---	25	25	--	--	1	1
	Total for Semester-I	**480**	**145**	**625**	**--**	**--**	**--**	**25**
M.Sc. PHYSICS SEMESTER-IV								
Code	Title of the Paper	Semester Examination			L	P	T	Credits
		Theory	IA	Total				
	Hard Core Theory							
HCT 4.1	Microelectronics	70	30	100	4	--	--	4
HCT 4.2	Physics of Nano Materials	70	30	100	4	--	--	4
HCT 4.3	Properties of Solids	70	30	100	4	--	--	4
	Soft Core-Theory (Any one)							
SCT 4.1	Experimental Techniques in Physics	70	30	100	4	--	--	4
SCT 4.2	Polymer Science &Technology							

	Practical (Hard and Soft core)							
MP	Major Project	140	60		--	8	--	8
	Seminar / Tutorial	---	25	25	--	--	1	1
Total for Semester-II		**480**	**145**	**625**	**--**	**--**	**--**	**25**

M.SC-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
HCT - 3.1: SEMICONDUCTOR DEVICES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 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 (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 gun 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:

19. D.A. Roustan: Bipolar Semiconductor Devices.
20. Mauro Zambuto: Semiconductor Devices.
21. D. Nagchoudhari: Semiconductor Devices.
22. Karl Hess: Advanced theory of semiconductors devices.
23. S. M. Sze: Physics of Semiconductor Devices 2nd edition..

24. A Dir - Bar - Lev: Semiconductor and Electronic Devices.
25. M. H. Rashid: Power Electronics.
26. P. C. Sen: Power electronics
27. B. G. Streetman and S. Banergee : Solid state Electronic Devices

M.SC-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
HCT - 3.2: ATOMIC MOLECULAR AND NUCLEAR PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

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 nonrigid
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 semiempirical 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 crosssection, 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 2ndEdi., 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

M.SC-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
SCT - 3.1: SOFT CONDENSED MATTER PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I Energy bands in solids (15)

The basic Hamiltonian in solid, Reduction to one electron problem for determining bands in solids (single particle approximation) - variational principle, Hartree approximation, Hartee-Fock approximation, Density functional approximation- Comparison with conventional wave function approach, Hohenberg-Kohn Theorem; Kohn-Sham Equation; Thomas-Fermi approximation and beyond; Practical DFT in a many body calculation and its reliability.

Unit-II Magnetism (15)

Origin of magnetism, quantum theory of diamagnetism, Landau diamagnetism,
Paramagnetism: Classical and quantum theory, magnetism in rare-earth and iron group atoms, quenching of orbital angular momentum, Van-Vleck Paramagnetism and Pauli Paramagnetism, Ferromagnetism: Cuire Weiss Law, temperature dependence of magnetization, Heisenberg exchange interaction, Ferromagnetic domains, Magnetic domains – exchange energy, magnetostatic energy, wall energy, magnetostrictive energy, Neel and Bloch wall, the Bloch T3/2 law, Neel model of antiferromagnetism and ferrimagnetism. Magnetic anisotropy and magnetostatic interactions- Direct, exchange, indirect exchange and itinerant exchange, (double exchange and RKKY interactions). Spin waves in ferromagnets - magnons, Spin waves in lattices –
ferri and antiferromagnetism, Measurement of magnon spectrum. Magnetic resonance and crystal field theory, Jahn-Teller effect; Hund's rule and rare earth ions in solids. Pinning effects, The Kondo effect, spin glass, solitons, Magneto resistance – spin valves and spin switches, giant magneto resistance (GMR), spintronics.

Unit-III Dielectrics and Ionics: Dielectric properties in solid – polarization, electrical conduction, dielectric loss, breakdown of dialectics, nonlinear dielectrics – ferroelectrics, junction capacitor, piezoelectric, electrets , impedance spectroscopy, complex dielectrics, eclectic modulus. Ionic conduction in solid: defect in solid, conduction mechanism, Nernst Einstein equation, cataonic, protonic and anionic conductor, temperature and frequency dependent of conductivity, hopping mechanism, universal power law (Jonscher's Power Law) oxygen ion conductor, solid electrolyte, fuel cell, SOFC.

Unit-IV Polymers, Composites and Soft matters (15)

Polymer and their classification, Molecular weight, degree of polymerization, techniques of polymerization, crystallinity of polymers, applications of polymers. Polymer electrolyte, conducting polymers- concept of solitons, polarons, biolarons, Doping in conducting polymers, Common conducting polymers, Properties and applications of conducting polymers: PLED, sensors actuators.
Composite Materials- various types of composites, microcomposites and mactrocomposites, fibre composites, and matrix materials, Different kinds of soft

matters, Symmetry and order parameters, Dispersion colloids, liquid crystal, biological membranes, macromolecules- DNA condensation, bilayer, Marcelja's molecular field theory mesosphere.

Recommended Books:

1) The Modern Theory of Solids- F.Sitz
2) Solid State Theory-W. Harrison, TMH,
3) Introduction to Solid State Physics by C. Kittel.
4) Solid State Physics – A.J. Dekker.
5) Introduction to Solid State Physics – H.P. Myers.
6) Solid state Physics – N.N. Ashcroft and N.D. Mermin.

M.Sc-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
SCT – 3.2: THIN FILM PHYSICS AND TECHNOLOGY
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit - I Chemical Methods of Thin films synthesis (15)

Chemical vapor deposition: Common CVD reactions, Methods of film preparation, laser CVD, Photochemical CVD, Plasma enhanced CVD. Chemical bath deposition: ionic and solubility products, preparation of binary semiconductors, Electrodeposition: Deposition mechanism and preparation of compound thin film Spray pyrolysis: Deposition mechanism and preparation of compound thin Films.Ion-assisted deposition (IAD), Laser ablation, Longmuir Blochet film, Sol-gel film deposition.

Unit -II Physical Methods of Thin Film Synthesis (15)

. Introduction to Thin Films, Thermal evaporation methods: Resistive heating, Flash evaporation, Laser evaporation, Electron bombardment heating, Arc evaporation, Sputtering process: Glow discharge, DC sputtering, Radio frequency sputtering, Magnetron sputtering, Ion beam sputtering.

Unit -III Physics of Surfaces, Interfaces and Thin films (15)

Mechanism of thin film formation: Formation stages of thin films, Condensation and nucleation, Thermodynamic theory of nucleation, Growth and coalescence of islands, Influence of various factors on final structure of thin films, Crystallographic structure of thin films. Properties of thin films: Conductivity of metal films, Electrical properties of semiconductor thin films, Transport in dielectric thin films, Dielectric properties of thin films, Optical properties of thin films. Thin films of high temperature superconductors, Diamond like carbon thin films

Unit -IV Thin films for Devices & other Applications (15)

Dielectric deposition- silicon dioxide, silicon nitride, silicon oxynitride, polysilicon deposition, metallization, electromigration, silicides. Thin film transistors, thin film multilayers, optical filters, mirrors, sensors and detectors.

References:

3. Ludmila Eckertova, Physics of thin films, 2nd Revised edition, Plenum Press, New York, 1986 (Reprinted 1990),

4. K.L. Chopra, Thin film phenomena, Mc-Graw Hill, New York, 1969.

5. L. C. Feldman and J.W. Mayer, Fundamentals of surface and Thin Films Analysis, North Holland, Amsterdam, 1986.

6. S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley, 1985.

Additional References:

3. R.W. Berry, P.M.Hall and M.T. Harris, Thin film technology, Van Nostrand, New Jersey, 1970, K.L.Chopra and LK.Malhotra (ed),

4. Thin Film Technology and Applications, T.M.H. Publishing Co., New Delhi (1984).

M.Sc-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
OET - 3.1: MEDICAL PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I: Forces acting on body and Physics of the skeleton (15)
Statics, Frictional forces, Dynamics, Conservation of Energy in the body, Heat losses from body, Pressure in the body. Physical properties of bone, Mechanics of joints,

Unit-II: Electricity within the body (15)
Nervous system and neuron, Electric properties of Nerve, Electrical potential of nerve, Nernst Equation, Bio potentials EMG, ECG, EEG, EOG, ERG, Magnetic signals from heart and Brain

Unit-III: Physics of hearing (15)
Basic definition of Audibility, Physics of ear, Human Audibility Curve, Sensitivity of ear, Testing of hearing. Deafness and hearing aids, Sound in medicine, Sound pollution, Effects of sound pollution on living body, Methods to minimize sound pollution.

Unit-IV: Physics of vision (15)
Optics of eye, Diffraction effects of eye, Refractive effect in eye and its correction, Contact Lenses, Color vision and chromatic aberration, Instruments used in Ophthalmology.

Reference Books:

1. Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons,Inter.Publ.
2 .Essential of Biophysics by Narayanan, New age Publication.
3. Radiation Biophysics by Edward Alphan, prentice Hall Advance Referes.
4. T.B. of Biophysics by R.N. Roy , Central Publication.
5. Medical Informatics by Smita Mishra and K. C. Mishra, ICFAI university.
6. Fundamental of Bioinformatics by Harisha. S.
7. Biomedical Engineering by S.N. Sarbadhikari, University press.
8. Principles of medical electronics &Biomedicalinstrumentation by c. Raja Rao, S. K. Guha , University press.
9. Electronics in medicine & Biomedical instrumentation by NandiniJog ,
10. Websites of the related topics

M.Sc-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
OET - 3.2: ENERGY HARVESTING DEVICES
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit -1: Solar Cells (15)

Photovoltaic effect, Solar cell characterization, Types of Solar cells, Solid state solar cells Silicon solar cell, CdTe based solar cells, CdS/Cu_2S solar cells, $CuInSe_2$ based solar cells, Metal-semiconductor solar cells, photoelectrochemical and photo electrolysis cells, Solar cells based on thin film heterojunctions, Ultra thin absorber solar cells, Nanostructured solar cells, Dye sensitised solar cells: basic concepts, working and materials. Organic Solar cells: basic concepts, working and materials.

Unit -2: Super Capacitors (15)

Comparison of battery and super capacitors, Super capacitor characterization, Types of super capacitors, double layer and pseudo capacitance, hybrid super capacitors, Recent status of carbon, RuO_2 and polyaniline based super capacitors, different methods for preparation of cathodic and anodic electrode materials, Fabrication of super capacitors with examples, Applications of supercapacitors

Unit -3: Fuel Cells (15)

Comparison between fuel cells and batteries, fuel cell characterizations, Types of fuel cells: Metal oxide, proton exchange membrane, Phosphoric acid, Solid oxide fuel cells, working of fuel cells, Materials for fuel cells, applications of fuel cells

Unit -4: Piezoelectrics (15)

Piezoelectric Energy Harvesting: Energy harvesting basis, case study
Piezoelectric Materials: Piezoelectric polycrystalline ceramics,Piezoelectric Single Crystal Materials, Piezoelectric and Electrostrictive Polymers, Piezoelectric Thin Films. Piezoelectric transducers, Mechanical energy harvester using Laser Micromachining, Mechanical energy harvester using PlezoelectricFibers, Piezoelectric Microcantilevers, Energy harvesting circuits, Multimadal energy harvesting, Mangetoelectric composites, Introduction to Piezoelectric bulk Power generators, Piezoelectric Micro Power Generators, Conversion efficiency, Power storage circuits

Reference Books

1. Semiconductor Sensors, S M Sze, A Wiley- Interscience Publication, John Wiley and Sons, NY1994
2. Electrochemical Supercapacitors, B E Conway, Kluwer Academic/ Plenum publishers, NY 1999.
3. C. N. R. Rao and Claudy Rayan Serrao, J. Mater. Chem., 2007, 17, 4931–4938
4. Solar Cells by Martin Green.
5. Photoelectrochemical Solar Cells by S. Chandra, Gordon &Breach Science Publisher, UK
5. Energy Harvesting Technologies, ShashankPriya, Daniel J. Inman Springer

M.SC-II, SEME. III, PHYSICS (CONDENSED MATTER PHYSICS)
SCT - 4.1: MICROELECTRONICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-21)

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-II, SEME. IV, PHYSICS (CONDENDED MATTER PHYSICS)
HCT - 4.2: PHYSICS OF NANO MATERIALS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Introduction (15)

Background of Nanoscience and Nanotechnology, Definition of Nanoscience and Nanotechnology, Possible Applications of Nanotechnology, Top-down and Bottom-up approach (Brief).

Band Structure and Density of States at Nanoscale: Introduction, Energy Bands, Density of States at Low - dimensional Structures, Quantum confinement – semiconductors, quantum wells, quantum wires, quantum dots, quantum rings. Manifestation of quantum confinement, quantum confinement effect, dielectric quantum confinement, effective mass approximation, core-shell quantum dots.

Unit II: Properties of Nanomaterials (15)

Optical properties: Absorption, transmission, Beer-Lamberts law (derivation), Photoluminscence, Fluorescence, Phosphorescence,Cathodoluminscence, Electroluminescence, Surface Plasmon resonance (SPR), effect of size of nanoparticles (metal, semiconductor) on absorption and SPR spectra.

Electrical transport: Electrical Conduction in Metals, Classical Theory - The Drude Model Quantum Theory - The Free Electron Model Conduction in Insulators/Ionic Crystals, Electron Transport in Semiconductors, Various Conduction Mechanisms in 3D (Bulk), 2D(Thin Film) and Low – dimensional Systems**,** Thermionic Emission Field – enhanced Thermionic Emission (Schottky Effect), Field - assisted Thermionic Emission from Traps (Poole - Frenkel Effect), Hopping Conduction, Polaron Conduction.

Unit III: Growth Techniques and Characterization Tools of Nanomaterials (20)

Growth techniques: Introduction, Top - down vs. Bottom - up Technique, Lithographic Process and its limitations , Nonlithorgraphic Techniques ,Plasma Arc Discharge Sputtering ,Evaporation, Chemical Vapour Deposition ,Pulsed Laser Deposition ,Molecular Beam Epitaxy, Sol - Gel Technique , Electrodeposition , Different chemical routes, Other Processes.

Characterization Tools of Nanomaterials: Scanning Probe Microscopy (SPM): Introduction, Basic Principles of SPM Techniques, The Details of scanning Tunneling Mocroscope (STM), General Concept and Definite Characteristics of AFM, Scanned - Proximity Probe Microscopes Laser Beam Deflection, AFM Cantilevers ,Piezoceramics, Feedback Loop Alternative Imaging Modes. Electron Microscopy: Introduction, Resolution vs. Magnification Scanning Electron Microscope SEM Techniques, Electron Gun Specimen Interactions Environmental SEM (FESEM), Transmission Electron Microscope, High Resolution TEM Contrast Transfer Function. Near-field scanning optical microscopy (SNOM/NSOM), UV-Vis single and dual beam spectrophotometer, photoluminescence spectrometer, X-ray diffractometer. Surface area and Pore size measurements (BET analysis)

Unit IV: Some Special Topics in Nanotechnology (10)

Introduction ,The Era of New Nanostructure of Carbon Buckminsterfullerene, Carbon Nanotubes, Nanodiamond, BN Nanotubes Nanoelectronics ,Single Electron Transistor, Molecular Machine, Nano-biometrics.

Reference Books:

15) **Introduction to Nanoscience and Nanotechnology:** K.K. Chattopadhyay and A.N. Banerjee, PHI Publisher
16) **Nanoscience and Technology:** V. S. Murlidharan, A. Subramanum.
17) **Nanotubes and Nanofibers:**YuryGogotsi
18) **A Handbook of Nanotechnology :** A. G. Brecket
19) **Instrumentations and Nanostructures:** A. S. Bhatia
20) **Nanotechnology: Nanostructures and Nanomaterials** - M. B. Rao
21) **Nanotechnology-Principles and practices** - S. K. Kulkurni (Capital Publication Company)

Reference Books:

1) Handbook ofApplied Solid State Spectroscopy, D. R. Vij, Springer
2) Phtoelectron and Auger Spectroscopy,T.A.Carlson, Plenum Press , 1975
3) Practical Guide to Surface Science and Spectroscopy,Yip-WahChung,Academic Press
4) Fundamental of Molecular Spectroscopy, C.N.Banwell,TataMc-Graw Hill.

M.SC-II, SEME. IV, PHYSICS (CONDENSED MATTER PHYSICS)
HCT - 4.3: PROPERTIES OF SOLIDS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit - I Optical and Dielectric properties (15)

Maxwell's equations and the dielectric function, Lorentz oscillator, the Local field and the frequency dependence of the dielectric constant, Polarization catastrophe, Ferroelectrics Absorption and Dispersion, Kraemers' Kronig relations and sum rules, single electron excitations and plasmons in simple metals, Reflectivity and photoemission in metals and semiconductors Interband transitions and introduction to excitons, Infrared spectroscopy.

Unit -II Transport Properties (15)

Motion of electrons and effective mass, The Boltzmann equation and relaxation time, Electrical conductivity of metals and alloys, Mathiessen's rule, Thermo-electric effects, Wiedmann-Franz Law, Lorentz number, ac conductivity, Galvanomagnetic effects.

Unit -III Magnetism and Magnetic materials (15)

Review: Basic concepts and units, basic types of magnetic order Origin of atomic moments, Heisenberg exchange interaction, Localized and itinerant electron magnetism, Stoner criterion for ferromagnetism, Indirect exchange mechanism: superexchange and RKKY.

Magnetic phase transition: Introduction to Ising Model and results based on Mean field theory, Other types of magnetic order: superparamagnetism, helimagnetism, metamagnetism, spin glasses.

Magnetic phenomena: Hysteresis, Magnetostriction, Magnetoresistance, Magnetocaloric and magneto-optic effect.

Magnetic Materials: Soft and hard magnets, permanent magnets, media for magnetic recording.

Unit -IV Superconductivity (15)

The phenomenon of superconductivity: Perfect conductivity and Meissner effect.

Electrodynamics of superconductivity: London's equations, Thermodynamics of the superconducting phase transition: Free energy, entropy and specific heat jump.

Ginzburg-Landau theory of superconductivity: GL equations, GL parameter and classification into Type I and Type II superconductors, The mixed state of superconductors.

Microscopic theory: The Cooper problem, The BCS Hamiltonian, BCS ground state Josephson effect: dc and ac effects, Quantum interference.

Superconducting materials and applications: Conventional and High Tc superconductors, superconducting magnets and transmission lines, SQUIDs.

Assignments: should be based on numerical problems related to the syllabus.

Main References:

1. 1. Solid State Physics, H. Ibach and H. Luth, *Springer(Berlin)* 2003 (IL)
2. Solid State Physics, Neil Ashcroft and David Mermin (AM)
3. Introduction to Solid State Physics (7th/ 8th ed) Charles Kittel (K)
4. Principles of Condensed Matter Physics, Chaikin and Lubensky (CL)

Additional References:

1. Principles of Condensed Matter Physics, Chaikin and Lubensky (CL)
2. Intermediate theory of Solids, Alexander Animalu (AA)
3. Optical Properties of Solids, Frederick Wooten, Ac Press (New York) 1972 (FW)
4. Electrons and Phonons, J M Ziman, Electron transport in metals, J.L. Olsen
5. Physics of Magnetism and Magnetic Materials, K.H.J. Buschow and F.R. de Boer Introduction to Magnetism and Magnetic Materials
6. Magnetism and Magnetic Materials, B. D. Cullity
7 Solid State Magnetism, J. Crangle
8 Magnetism in Solids, D. H. Martin

M.SC-II, SEME. IV, PHYSICS (CONDENSED MATTER PHYSICS)
SCT - 4.1: EXPERIMENTAL TECHNIQUES IN PHYSICS
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit-I Electronic instrumentations (15)

Measurement system- mechanical and electrical, Transducers and its types, sensors, differential output transducer, LVDT, Hygrometers, Measurement of thermal Conductivity (gas analyzer), Physiological transducers Bio-potential electrodes. Digital and analog measuring instruments – voltmeter, ammeter, oscilloscope, power meter, LCR meter, instrumentation amplifier, filtering and noise reduction in instruments, shielding and grounding, lock-in detector, box-car integrator, interfacing sensors and data acquisition, Integrated circuits technology – fabrications, Power supplies- primary and secondary cell, regulated power supply, SMPS, UPS, Step down switching regulator, Inverters- voltage driven inversion, current driven inversion.

Unit-II Lasers and Optoelectronic instrumentation (15)

Lasers: - Temporal and special coherence, Einstein coefficients, The threshold condition, two, three and four level laser systems, Modes of a rectangular cavity and open planar resonator, Quality factor, mode selection, The Ruby laser, The Helium-Neon laser, the carbon dioxide (CO2)laser. Optoelectronic devices : Photoconductivity, LDR, photodiode, phototransistor, solar cell, metal semiconductor detector, LCD, CCD , LED, Laser diode, PIN photodiode, Avalanche photodiode, Heterojunction photodiode, Organic light emitting diodes,. Optical fiber- ray propagation Step –index and graded-index fibers, dispersion and attenuation in fiber optics, Dispersion compensation mechanism, Erbium-doped fiber amplifiers, Optoelectronic modulators.

Unit III (a). X-ray analysis (15)

Origin of X-rays, X-ray generators. Scattering of X-ray, atomic scattering factor, Diffraction of X-ray, various X-ray diffraction methods, X-ray powder diffraction method -indexing of powder lines, Laue's method, rotational/oscillation method, X-ray diffractormeter, determination of crystal structure and lattice parameter, small angle x-ray diffraction and its applications. XPS, XRF and its applications.

(b).Low pressure and Low temperature: Production of low pressure -Rotary, oil diffusion, turbo molecular, getter and cryo pumps; gauges – Macleod thermoelectric (thermocouple, thermistor and pirani), penning, hot cathode partial pressure measurement; leak detection; gas flow through pipes and apertures; effective pump speed; vacuum components. Production of Low temperature**:** Gas liquifiers; Cryo -fluid baths; liquid He cryostat design; closed cycle He refrigerator; low temperature measurement.

Unit-I Analytical Instrument (15)

Electron Microscopy (SEM, TEM, HRTEM), Scanning probe microscopy (AFM, MFM, STM), UV-Vis, spectroscopy and its applications. FT-IR spectroscopy, Luminescence spectroscopy techniques- Fluorescence spectroscopy, Raman spectroscopy, Thermal analysis using DTA, TGA, DSC; Electronic transport analysis using Current vs Voltage characteristics – two probe and four probe techniques - various types of contacts, Dielectric and impedance spectroscopy, spectrum analyzer, fluorescence and Raman spectrometer, Interferometers for different analytical study.

Recommended Books:

1) Electronic Instrumentation - Kalsi H S

2) X-Ray Crystallography – B.E. Warren.
3) Materials Characterization: Introduction to Microscopic and Spectroscopic Methods,
4) Materials Characterization Techniques Sam Zhang, Lin Li, Ashok Kumar

M.SC-II, SEME. IV, PHYSICS (CONDENSED MATTER PHYSICS)
SCT - 4.2: POLYMER SCIENCE AND TECHNOLOGY
Choice Based Credit System (CBCS)
(w. e. f. June 2020-2021)

Unit I: Historical developments in polymeric materials (15)
Basic concepts & definitions: monomer & functionality, oligomer, polymer, repeating unites, degree of polymerization, molecular weight & molecular weight distribution.

Unit II: Natural Polymers (15)
Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc.

Unit III: Methods of Polymer Synthesis (15)

Unit IV: Applications of Polymers
(15)

Textbooks/Sourcebooks:
1. Raw Materials for Industrial Polymers by H Ulrich, Hanser Publication1989.
2. Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
3. Polymer Science by Gowarikar, Johan wiley and Sons 1986.
4. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
5. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
6. Petrochemicals the Rise of an Industry by Peter H. Spitz, Johan Wiley and sons 1988.
7. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.

HCP 3.1/3.2

25) Susceptibility measurement of $FeCl_3 6H_2O$ solution.
26) Successive Ionic Layer Adsorption and Reaction.
27) Chemical Bath deposition of PbS.
28) Chemical Bath deposition of CdS.
29) Strain gauge II.
30) Optical studies on CdS thin film (α vs λ, determination of E_g and m).
31) LVDT II.
32) Band gap determination using four probe method.
33) Hydroxide co-precipitation of $Ba_{0.8}Sr_{0.2}\,TiO_3$
34) Electrodeposition of Ni.
35) Ceramic synthesis of PZT.
36) Antocombustionsyrthesis of $Cofe_2O_4$.

SCP 3.1

15) Faraday Effect.
16) Kerr Effect.
17) Pockel Effect.
18) Electrical conductivity measurement and determination of activation energy.
19) Thermoelectric power measurement.
20) Determination of Curie temperature.
21) Particle size estimation.

_____xxxx_____