"Dissemination of Education for Knowledge, Science and Culture"

-Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Empowered Autonomous).

DEPARTMENT OF PHYSICS

Two - Years PG Programme

Department/Subject Specific Core or Major (DSC)

Curriculum, Teaching and Evaluation Structure

for

M.Sc. I - Physics

Semester – I & II

(Implemented from academic year 2024-25 onwards)

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

M. Sc. I - Physics

Program Outcomes (POs):

PO1	The student will acquire a job efficiently in diverse fields such as Science and Engineering, Industry, Education, Banking, Public Services, Business.
PO2	The student will effectively communicate their knowledge of physics through a variety of oral, Written and computational modalities.
PO3	The student will be able demonstrate a purposeful knowledge of scientific literature and ethical issues related to physics.
PO4	Assess the errors involved in an experimental work and make recommendations based on the results in an effective manner also gain the knowledge of Physics through theory, Practical's and research project.

Program Specific Outcomes (PSOs):

PSO1	The student will acquire a comprehensive knowledge and sound understanding of fundamentals of Physics and will be able to apply a scientific knowledge gained through core and specialized physics papers
PSO2	The student will be able to develop practical, analytical and mathematical skills in Physics and determine the appropriate level of technology in practice • Experimental design and implementation. • Analysis of experimental data and awareness of handle the sophisticated instruments/ equipment's. • Numerical and mathematical methods in problem solving. • Acquire a range of general skills. • To evaluate information. • To use computers productively. • To communicate with society effectively and learn independently. • To develop the skill to plan, Execute and report the results of an extended experimental or theoretical Physics based on project in Masters Programme. • Demonstrate, Solve and an understanding of major concepts in all disciplines of Physics
PSO3	Understand and apply principles of physics for understanding the scientific phenomenon in classical and quantum physics.
PSO4	The student will become effective researcher who will be able to publish scientific papers, Articles on a given topic of study and gain knowledge to continue research at the higher degree (PhD) level.

VIVEKANAND COLLEGE, KOLHAPUR (EMPOWERED AUTONOMOUS)

Department of Physics

Departmental Teaching and Evaluation scheme

Three/Four- Years UG Programme

Department/Subject Specific Core or Major (DSC)

(as per NEP-2020 Guidelines)

M.Sc. I, Semester-I & II

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR	Marks	
Semester-I										
1	DSC-I	DSC12PHY11	Mathematical Physics	4	-	80	20	-	100	4
2	DSC-II	DSC12PHY12	Classical Mechanics	4	-	80	20	-	100	4
3	RMD-I	MIN12PHY11	Research Methodology	4	-	80	20	-	100	4
4	DSC-I OR DSC-II	DSE12PHY11	Solid State Physics-I (Semiconductor Physics)	4	-	80	20	-	100	4
5		DSE12PHY12	Material Science -I Imperfection in Crystals	4	-	80	20	-	100	4
6	DSC-PR-I	DSC12PHY19	DSC-Physics Lab-I	-	6	-	-	150	150	6
Semester –I Total				**16**	**6**	**320**	**80**	**100**	**550**	**22**
Semester- II										
1	DSC-III	DSC12PHY21	Quantum Mechanics	4	-	80	20	-	100	4
2	DSC-IV	DSC03PHY42	Condensed Matter Physics	4	-	80	20	-	100	4
3	DSC-I OR DSC-II	DSE12PHY21	Solid State Physics-II (Semiconductor Physics)	4	-	80	20	-	100	4
4		DSE12PHY22	Material Science -2 Properties of Materials	4	-	80	20	-	100	4
5	DSC-PR-II	DSC12PHY29	DSC-Physics Lab-II	-	6	-	-	150	150	6
6	FPR/OJT	FPR12PHY21 OR OJT12PHY21	On Job Training/ Field Project	-	4	-	-	100	100	4
Semester –IV Total				**12**	**10**	**240**	**60**	**250**	**550**	**22**

M.Sc. I, Semester-I (DSC-I)
Mathematical Physics
DSC12PHY11
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Mathematical Physics

CO1	Well-versed with the Matrices.
CO2	Understand the elementary ideas and have acquired facility mastered the numerical tools for solving mathematical problems with complex variables.
CO3	Can understand the complications associated with the Fourier Series and Transform.
CO4	Learn about the concept of some special functions, Frobenius power series and polynomials.

Mathematical Physics

Unit	Syllabus	Hours
Unit 1	**Vector Spaces and matrices** Linear vector space, Matrix multiplication – inner product, direct product, diagonal matrices, trace, matrix inversion, example of Gauss-Jordon inversion, problems, eigen values and eigen vectors, properties of eigen values and eigen vectors, Cayley- Hamilton theorem and applications, similar matrices, diagonalizable matrices, eigen values of some Special complex matrices, quadratics forms, problems.	15
Unit 2	**Differential equations and Special functions** Solution for first order differential equation, Bernoulli equation, exact equation, second order linear differential equation with constant and variable coefficient, special functions (Hermite, Bessel, Laguerre, and Legendre functions), generating functions, recurrence relation	15
Unit 3	**Fourier- Series, Integral, and Transform** Definition, Dirichelet's Theorem, evaluation of coefficients of Fourier series (Cosine and Sine Series), graphical representation of a square wave function, complex form of Fourier series, Fourier integral exponential form, applications of Fourier series analysis in physics (square wave, full wave rectifier, expansion of Raman Zeta function). Fourier transform, inversion theorem, exponential transform example: full wave train, uncertainty principle. Dirac delta function, derivative of δ- function and Laplace Transform of δ- function.	15
Unit 4	**Complex Analysis** Analytical functions, Cauchy-Riemann conditions, Cauchy's theorem, Cauchy integral formula, derivatives of analytical functions, Taylor's theorem, Laurent's theorem, residues, evaluation of definite integrals.	

Reference Books:

1) Mathematical Physics - Rajput B. S., Pragati Prakashan (Meerat),1999.
2) Mathematical Methods - Iyengar S. R. K., Jain R. K., Narosa, 2006.
3) Mathematical Methods for Physicists (6th Edition) - Arfken and Weber, Academic Press, 2005.
4) Mathematical Physics-Binoy Bhattacharyya, New Central Book Agency (P) Limited, 2010.
5) Complex Variables and Applications - J. W. Brown, R. V. Churchill – (7th Edition) - Mc-Graw Hill,2009
6) Complex Variables –Seymour Lipschutz, John J. Schiller, Dennis Spellman, (2nd Edition) Mc-Graw Hill,2009

M.Sc. I, Semester-I (DSC-II)
Classical Mechanics
DSC12PHY12
Theory: 60hrs
Marks-80 (Credits: 04)

Course outcomes: Classical Mechanics

CO1	Understanding of Mechanics and Lagrange's and Hamilton's theory.
CO2	Gain basic knowledge of Canonical Transformation and Special Relativity and the evolutionary significance of it.
CO3	Learn about the concept of canonical transformation, Coupled oscillation
CO4	Able to solve problems regarding classical mechanics

Classical Mechanics

Unit	Syllabus	Hours
Unit 1	**Central Force Problem and Small oscillations:** Two body problem, The equation of motion and first integrals, Equation of orbit, Kepler's laws, Kepler's problem, General analysis of orbits, Stability of orbits, Rutherford Scattering: Differential scattering cross section, Rutherford Formulae for scattering, Virial theorem. Small oscillations: Potential energy and equilibrium-one dimensional oscillator, general theory of small oscillations.	15
Unit 2	**Variational principle and Hamiltonian Dynamics:** Variational principle, Deduction of canonical equations from Variational principle, Principle of least action with proof, Hamilton's principle, Hamiltonian, Generalized momentum & Conservation Theorems using cyclic coordinates, Hamilton's canonical equations of motion, Applications of Hamilton's equations of motion-i) Simple Pendulum ii) Compound Pendulum iii) Linear Harmonic Oscillator, Problems.	15
Unit 3	**Canonical Transformations and Poisson's Brackets:** Legendre transformations, Generating Functions, Illustrations of Canonical transformations, Condition for Canonical Transformation, Examples. Poisson's Brackets, Poisson's theorem, Properties of Poisson's Brackets, Lagrange Bracket, Relation between Lagrange and Poisson's Brackets, Hamilton's Canonical equations in terms of Poisson's Brackets, Hamilton–Jacobi Theory, Solution of harmonic oscillator problem by HJ Method, Problems.	15
Unit 4	**Special Theory of Relativity and Relativistic Mechanics:** Special theory of relativity and its postulates, Galilean transformations, Lorentz transformations, Relativistic kinematics (Relativity of Mass, Length, Time), Minkowski Space, 4-Vectors, 4- Momentum, Lorentz Tensor, Addition of velocities, Mass-Energy relation, Force in relativistic	15

	mechanics, Lagrangian formulation of relativistic mechanics, Particle accelerating under constant force, Hamiltonian formulation of relativistic mechanics, Relativistic Doppler's Effect.	

Reference Books:

1) Classical Mechanics- H Goldstein, Addison Wesley, 1980.
2) Classical Mechanics- J. C. Upadhyaya, Himalaya Publishing House, 2015.
3) Classical Mechanics- N. C. Rana and P. S. Joag, Tata McGraw Hill, 1991.
4) Introduction to Classical Mechanics- R. G. Takwale and P. S. Puranik, Tata McGraw Hill,1999.
5) Classical Mechanics by Gupta- Kumar and Sharma, Pragati Prakashan, 2000.

M.Sc. I, Semester-I
Research Methodology
RMD12PHY11
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Research Methodology

CO1	Understand the meaning of research, research design
CO2	Understand the methods of data collection
CO3	Learn about various tool of literature survey
CO4	Learn about Thin film deposition technics and also learn how to study properties and analysis of thin films.

Research Methodology

Unit	Syllabus	Hours
Unit 1	**Research Methodology**: **i)** Meaning of research, objectives of research, motivation in research, types of research, research approaches, significance of research, research methods versus research and scientific methodology, importance of knowing how research is done, research progress, criteria of good research. **ii)** Research design: meaning of research design, features of good design, important concepts of relating research design, different research designs, Basic principles of experimental designs. **iii)** Method of data collection, types of data analysis; statistics in research, measure of central tendency, measure of dispersion; measure of asymmetry, measure of relationship, simple regression analysis, multiple correlation and regression, partial correlation.	15
Unit 2	**Literature Searching and Report Writing:** **i)**Literature Searching: On-line searching, Database, SciFinder, Scopus, Science Direct, CA on CD, Searching research articles,Citation Index, Impact Factor, h-index etc, **ii)**Writing scientific report: Structure and components of research report, revision, and refining writing project proposal, Paper writing for International Journals, submitting to editors, conference presentation, preparation of effective slides, pictures, graphs, and citation styles. **iii)**Thesis writing: the preliminary pages and the introduction, the literature review, methodology, the data analysis chapters, conclusion.	15
Unit 3	**Vacuum:** Production of low pressures: rotary, diffusion, and sputter ion pumps; measurement of low pressure: McLeod, Pirani, thermocouple & Penning	15

	gauges; leak detection: simple methods of LD, palladium barrier and halogen leak detectors.	
Unit 4	**Low Temperature and Microscopy Techniques:** Production of low temperatures: Adiabatic cooling, the Joule-Kelvin expansion, adiabatic demagnetization, ^{3}He cryostat, the dilution refrigerator, principle of Pomeranchuk cooling, principle of nuclear demagnetization; measurement of low temperatures. Optical microscopy, scanning electron microscopy, electron microprobe analysis, low energy electron diffraction.	15

Reference Books:

1) Fundamentals of computers- Morley & Parkar, Cengage Learning Pvt. Ltd. New Delhi, 2009.
2) Research Methodology- Methods and Techniques, C. R. Kothari, Wiley Easter Ltd, New Delhi, 1985.
3) Writing your thesis- Paul Oliver, Vistaar Publication, New Delhi, 2014.
4) High vacuum techniques- J. Yarwood (Chapman & Hall), 1967.
5) Vacuum technology- A. Roth, North-Holland Publishing Company, Amsterdam, 1982.
6) Experimental techniques in low temperature physics- G. K. White, Oxford, 1968.
7) Low temperature physics – L.C. Jackson, Methuen And Company Limited, 1934

Elective Paper

Sr. No.	Course Code	Paper Title
1	DSE12PHY11	SSP-1 (Semiconductor Physics) (4 credits)

M.Sc. I, Semester-I
Solid State Physics-I
(Semiconductor Devices)
DSC12PHY11
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Solid State Physics-I

CO1	A critical and systematic understanding of energy bands and charge carriers in Semiconductors.
CO2	Learn the basics of excess carriers in semiconductors, Optical absorption, Luminescence, diffusion and drift of carriers.
CO3	Provide a broad view of fabrication of p-n junctions and current flow through at a junction, Capacitance of p-n junctions, heterojunction.
CO4	Understand the concepts of diode

Solid State Physics-I
(Semiconductor Devices)

Unit	Syllabus	Hours
Unit 1	**Energy Bands and Charge Carriers in Semiconductors:** Direct and Indirect semiconductors, variation of energy bands with alloy composition, Charge carriers in semiconductors: electrons and holes, effective mass, intrinsic and extrinsic semiconductors, electrons and holes in quantum wells, The Fermi level, carrier concentration at equilibrium, temperature dependence, space charge neutrality, conductivity and mobility, Drift and resistance, effects of temperature and doping on mobility, Hall effect.	15
Unit 2	**Excess Carriers in Semiconductors:** Optical absorption, Luminescence: photoluminescence and electroluminescence, Direct recombination of electrons and holes, Indirect recombination and trapping, steady state carrier generation and Quasi Fermi levels, Diffusion processes, Diffusion and Drift of carriers, built-in fields, The continuity equation, steady state carrier injection, diffusion length.	15
Unit 3	**Junctions-I:**	15

	Fabrication of p-n junctions; Thermal oxidation, diffusion, Chemical vapor deposition (CVD), Photolithography, etching, metallization, The contact potential, Space charge at a junction, qualitative description of current flow at a junction, reverse-bias breakdown, Capacitance of p-n junctions, Zener and Avalanche breakdown, rectifiers.	
Unit 4	**Junctions-II:** The tunnel diode, the Varactor diode, recombination and generation in the transition region, ohmic losses, graded junctions, Schottky barriers, rectifying contacts, ohmic contacts, hetero-junctions, AlGaAs-GaAs hetero-junction.	15

Reference Books:

1) Solid state electronic devices- B. G. Streetman., Prentice Hall India Learning Private Limited; 6th edition 2006.
2) Physics of semiconductor devices- S. M. Sze., John Wiley & Sons, 2006
3) Solid State and Semiconductor Physics- McKelvey.,1982.
4) Principles of Electronic Materials and Devices- S.O. Kasap, McGraw Hill Education; 3rd edition, 2017

OR

Elective Paper
M.Sc. I, Semester-I
Imperfection in Crystals
DSC12PHY12
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Imperfection in Crystals

CO1	Understanding Crystal Structures and Defects Comprehend the fundamental concepts of crystal structures
CO2	Identify the Dislocations are line defects in a crystal structure that play a key role in the deformation behavior of materials.Types of Dislocations
CO3	Understand the Fundamental Principles of Diffusion and Derive and solve Fick's first and second laws for various boundary conditions. The thermodynamics and kinetics of phase transformations during solidification. Understand nucleation and growth processes.
CO4	Understand the are essential tools in materials science, helping to predict the phase changes and microstructures of materials under different conditions.

Imperfection in Crystals

Unit	Syllabus	Hours
Unit 1	**Point defects:** Crystalline materials, Types of Defects in crystalline materials (Point Defects, Stacking Faults, Grain Boundaries, Twin Boundaries, Volume Defects), Point defects in metallic and non-metallic crystals, lattice distortion, migration energy, point defects in thermal equilibrium, point defects in ionic crystals, equilibrium concentration of Frenkel and Schottky defects, ionic conductivity, point defects in nonthermal equilibrium.	15
Unit 2	**Dislocations:** Concept and types of dislocation, Dislocations and non-uniform slip, Edge dislocation, Screw dislocation, Curved dislocation line on plane slip surface, Effect of atomic structure on the form of a dislocation (Central force approximation, Bubble model, Directional bonds, Cottrell atmosphere, imperfect or partial dislocations, stacking faults), Thomson tetrahedron, partial dislocations in other crystal structures, multiplication of dislocations, Jogs and their formation, motion of a vacancy jog, measurement of stacking fault energy.	15
Unit 3	**Diffusion and Solidification:** **Diffusion:** Fick's laws of diffusion, solutions to the diffusion equation, calculation of jump frequency, mechanisms of diffusion, self-diffusion, diffusion - along grain boundaries.	15

	Solidification: Homogeneous nucleation, heterogeneous nucleation, atomic kinetics, solute manipulation (normal freezing, zone melting & zone refining).	
Unit 4	**Principles and applications of phase diagrams:** Freezing of a pure metal, Plane-front and dendritic solidification at a cooled surface, Gas porosity and segregation, Directional solidification, Production of metallic single crystals for research, The concept of a phase, The Phase Rule, Stability of phases, Two-phase equilibria, Three-phase equilibria and reactions, Intermediate phases, Limitations of phase diagrams.	15

Reference Books:

1) Physical metallurgy - R.W. Cahn, II Edition, North Holland, Amsterdam,1970.
2) Introduction to dislocations - D. Hull, ELBS, 1971.
3) Imperfections in crystals - Van Burren, North Holland, 1960.
4) Theory of crystal dislocations - F.R.N. Nabarro, Clarendon Press, 1968.
5) Dislocations in crystals - W.T. Read, McGraw Hill, 1953.
6) Modern physical metallurgy - R.E. Smallman, Butterworths, 1970.
7) Techniques of metal research - R.F. Bunshaw, Interscience, 1968.
8) Modern techniques in metallography - D.G. Brandon, Butterworths, 1966.

M.Sc. I, Semester-I
Physics Lab-I (DSE-PR I)
DSC12PHY19(6)
Mark: 150 (Credits 06)

1. Hall effect (Hall coefficient & carrier concentration of semiconductor).
2. Linear Variable Differential Transducer.
3. Crystal structure identification by Neutron diffraction pattern.
4. Wavelength of given source by using Fabry-Parrot etalon.
5. Crystal structure identification by X- ray diffraction pattern.
6. Structure identification of given samples (F.C.C.& B.C.C.)
7. Monatomic/ diatomic lattice vibrations using lattice dynamics kit.
8. Characteristic of Temperature Transducers (Thermocouple, Thermistor and IC sensor)
9. Specific heat capacity of given metals.
10. Staircase Ramp Generator using UJT
11. Negative feedback amplifier (with and without feedback)
12. Astable multivibrator
13. Monostable multivibrator.
14. Stefan's constant.
15. Magnetic parameters of given sample using B-H curve kit
16. Thermal & electrical conductivity of copper.
17. Numerical, algebraic, and trigonometric problems using Mathematica.
18. Analysis of statistical data.
19. Numerical differentiation using Python.
20. Numerical integration using Python.
21. Physical density of material by using Archimedes' Principle.

Vivekanand College, Kolhapur (Empowered Autonomous)

M.Sc. I, Semester-II
Quantum Mechnics (DSC-III)
DSC12PHY21(4)
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Quantum Mechanics

CO1	Students would understand basic concepts in the Origin and general formalism and representation of states and quantum dynamics.
CO2	Students develop theoretical knowledge of Angular Momentum operator
CO3	Students develop important basic understanding about time independent perturbation theory, and its applications.
CO4	Students develop important basic understanding angular momentum, operators, approximation method etc.

Quantum Mechnics (DSC-III)

Unit	Syllabus	Hours
Unit 1	**Mathematical Tools of Quantum Mechanics:** Hilbert space and wave function, Dirac notations, Operators (General definitions, Hermitian adjoint operator, projection operators, uncertainty relation between two operators, functions of operators, inverse and unitary operators, eigenvalues and eigenvectors of an operator, parity Representation in continuous bases (Position representation, Momentum representation and connection between them), Matrix representation of orbital and spin angular momentum.	15
Unit 2	**Variational Method and WKB Approximation:** The variational principle, Rayleigh-Ritz method, variational method for excited states, the Hellmann Feynman theorem, ground state of harmonic oscillator, infinite square well, hydrogen atom, the WKB method, the connection formulas, validity of WKB method, barrier penetration, Alpha emission.	15
Unit 3	**Perturbation Theory:** Time independent perturbation: basic concept, non-degenerate energy levels, Eigen value of energy and Eigen function in the first order approximation, Anharmonic oscillator: first order correction, first order correction to ground state of helium. The pictures of quantum mechanics (Schrodinger picture, Heisenberg picture and Interaction picture), Time dependent perturbation: Basic concept, Dyson series, First-order perturbation, transition probability, constant perturbation, harmonic perturbation, transition to continuum states (Fermi-Golden rule), semi-classical theory of radiation: absorption and emission of radiation, electric dipole approximation, Einstein’s A and B coefficients.	15

Unit 4	**Scattering Theory:** Scattering cross-section, scattering amplitude, partial wave, scattering by central potential: partial wave analysis, optical theorem, scattering by hard sphere, scattering by square well, Breit-Wigner formula, scattering length, expression for phase shifts, integral equation, the Born approximation, scattering by screened Coulomb potential, scattering by Yukawa potential, validity of Born approximation.	15

Reference Books:

1) Quantum Mechanics: Concepts and Applications- Zettili Nouredine, John Wiley & Sons Ltd., Second Edition, 2009.
2) Quantum Mechanics- Aruldhas G, Prentice Hall India Learning Private Lt., 2nd Edition, 2009.
3) Introduction to Quantum Mechanics- David J. Griffiths, Pearson Education, 2nd Edition, 2015.
4) Quantum Mechanics: Theory and Applications- Ajoy Ghatak and S. Lokanathan, Macmillan Publishers India, Fifth Edition 2004.
5) Modern Quantum Mechanics- J. J. Sakurai and Jim J. Napolitano, Pearson Education India, 2nd Edition, 2013.

M.Sc. I, Semester-II
Condensed Matter Physics (DSC-IV)
DSC12PHY22
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Condensed Matter Physics

CO1	Understand and describe various crystal structures in crystallography.
CO2	Describe and understand fundamental concepts of crystal defects.
CO3	Discuss different aspects of Dielectric, Magnetism & Superconductivity.
CO4	Assess and critique semiconductor theory and semiconductor materials, which will eventually lead to a general framework of concepts applicable to a variety of semiconductor devices.

Condensed Matter Physics (DSC-IV)

Unit	Syllabus	Hours
Unit 1	**Crystal Physics:** Crystalline state of solid, unit cell and Bravais lattice (2D and 3D), bonding of common crystal structure, direction, position, and orientation of planes in crystal, concept of reciprocal lattice, concept of Brillouin zones, closed packed structure, Fourier analysis of the basis (structure factor), Bragg's law, comparison of X-ray, electron and neutron diffraction method.	15
Unit 2	**Crystal Defects:** Types of defects, Point defects-Vacancies, Interstitials, impurities, electronic, Line defects-Edge and screw dislocation, Schottky and Frenkel defect, Expression for Schottky and Frenkel defects, equilibrium concentration of vacancies, color center, line defect, screw and edge dislocation, Berger's vector and circuit, role of dislocation in plastic deformation and crystal growth, observation of imperfection in the crystals, Frank-Read mechanism, Planer defects, Surface defects- Grain boundaries, Tilt boundaries, Twin boundaries, Effect of Imperfections.	15
Unit 3	**Semiconducting and superconducting properties:** **Semiconductor:** Determination of Band gap energy, direct and indirect band gap, effective mass, intrinsic and extrinsic semiconductors, carrier concentration, Fermi level and conductivity for intrinsic and extrinsic semiconductor, impurity level in doped semiconductor, Hall Effect, Quantum Confinement. **Superconductor:** Critical temperature, effect of magnetic field, Meissner effect, type-I and type II superconductor, London equation, coherence length, Josephson effect (flux quantization), BCS theory, introduction of high Tc superconductor, SQUID, Cooper pairing in superconducting dots.	15

Unit 4	**Dielectrics and Magnetism:** **Dielectrics:** Polarization mechanism, dielectric constant, Lorenz cavity field, Clausius-Mossotti equation, ferroelectricity and piezoelectricity, type of ferroelectric and piezoelectric materials **Magnetism:** Classification of magnetic materials, Langevin theory of diamagnetism, paramagnetism and ferromagnetism, theory of diamagnetism- Heisenberg exchange interaction theory (ferro, antiferro and ferrimagnetism), Weiss theory of ferromagnetism. Comparison between dia, para and ferromagnetism, Super-paramagnetism.	15

Reference Books:

1) Introduction to Solid State Physics- Kittel, 8th Edn. JohnWiley & Sons. Inc., New York, 2019.
2) Solid State Physics- A. J. Dekker, MacMillan India Ltd.,1986.
3) Solid State Physics- N. W. Ashcroft and N. D. Mermin, HRW International edn. 1976.
4) Solid State Physics- S. O. Pillai. New Age International Publication.2002.
5) Solid State Physics- H. C. Gupta-Vikas Publishing House, New Delhi-2002.
6) Electronic Properties of Materials- R.E.Humel, 2nd Edn.Springer International 1994.

Elective Paper
M.Sc. I, Semester-II
Semiconductor Devices
DSE12PHY21
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Semiconductor Devices

CO1	Understand the working ,structure and operation and functions of (BJT), (JFET), MOSFET, MESFET, and diodes.
CO2	Identify the problems and applications of Magneto-optic and acousto-optic, Piezoelectric, Electrostrictive and magnetostrictive effects.
CO3	Acquire basic knowledge about Light emitting Diodes, OLED, Infrared LED, Photodetector, Photoconductor, Photodiode, p-n junction Solar cells, Semiconductor Lasers
CO4	Learn the techniques of Thermistor, and sensors.

Semiconductor Devices

Unit	Syllabus	Hours
Unit 1	**Transistors and Microwave Devices:** Bipolar junction transistor (BJT), Frequency response and switching of BJT, Base Narrowing, Ebers-Moll Model, Gummel–Poon Model, Kirk Effect, Field effect transistor (FET), JFET, MOSFET, MESFET, Tunnel diode, Transferred electron devices and Gunn diode, Avalanche transit time diode and, IMPATT diode.	15
Unit 2	**Photonic Devices:** Optical absorption, Radiative and non-radiative transitions, Light emitting diodes, Organic LED, Infrared LED, Photo detector, Photoconductor, Photodiode, Solar cells, Semiconductor Lasers.	15
Unit 3	**Memory Devices:** Number system and its conversion to binary number, Semiconducting memories, Memory organization, Read and Write operation, expanding memory size, Classification and characteristics of memories, Static and dynamic RAM, Charge couple memory (CCD) devices, Magnetic, optical, ferroelectric, Spintronic and other memory based devices.	15
Unit 4	**Other electronic Devices:** Magneto-optic and acousto-optic effects, Material’s properties related to get these effects, Piezoelectric, Electrostrictive and Magnetostrictive effects, Sensors, and actuator devices.	15

Reference Books:

1) Semiconductor devices: Physics and Technology 2nd Edition, S. M. Sze, Wiley, 2016.
2) Modern Digital Electronics, R. P. Jain, McGraw Hill Education,2009.
3) Introduction to Semiconductor devices by M. S. Tyagi, Wiley, 2008.
4) Optical electronics by Ajoy Ghatak and K. Thyagrajan, Cambridge University Press.Cambride India, 2017.

OR

Elective Paper

M.Sc. I, Semester-II
Properties of Material
DSE12PHY22(4)
Theory: 60hrs
Marks-80 (Credits: 04)

Course Outcomes: Properties of Material

CO1	Understanding how materials behave under different conditions and for selecting the right material.
CO2	Understanding these properties is crucial for applications involving heat transfer, thermal management, and materials exposed to varying temperature conditions.
CO3	Understanding the electric and magnetic properties of materials is essential for designing and optimizing a wide range of electronic and magnetic devices.
CO4	Understanding the optical properties of materials is essential for the design and optimization of a wide range of applications in optics and photonics.

Properties of Material

Unit	Syllabus	Hours
Unit 1	**Physical and mechanical properties of the materials:** Stress Versus Strain (metals, ceramics and glasses, polymers), Elastic Deformation, Plastic Deformation, Hardness, Creep and Stress Relaxation, Viscoelastic Deformation.	15
Unit 2	**Thermal Properties:** Thermal expansion, Thermal conductivity, Thermal shock, Specific heat capacity, The specific heat curve and transformations, Free energy of transformation.	15
Unit 3	**Electric and magnetic properties:** Electric properties: Electric conductivity, Semiconductors, Hall Effect, Superconductivity, Oxide superconductors, Magnetic properties: Magnetic susceptibility, Diamagnetism, Paramagnetism, Ferromagnetism, Magnetic alloys, Anti-ferromagnetism and ferrimagnetism, Dielectric materials, Polarization, Capacitors and insulators, Piezoelectric materials, Pyroelectric and ferroelectric materials.	15
Unit 4	**Optical Properties:** Optically active materials, Reflection, absorption and transmission effects, optical fibers, ceramic windows, electro-optic ceramics.	15

Reference Books:

1) Physical metallurgy- R. W. Cahn, II Edition, North Holland, Amsterdam, 1970.
2) Physical metallurgy- R. W. Cahn and P. Haasen, III Edition, North Holland, Amsterdam, 1983.
3) Physical metallurgy principles - R.E. Read-Hill, Affiliated East West Press Ltd.,New Delhi,1970.
4) Modern physical metallurgy- R.E. Smallman, Butterworths, London, 1970.
5) Physical properties of glass- D. G. Holloway Wykeham publications, London, 1973.
6) An introduction to metallurgy – A.H. Cottrell, Edward Arnold, London, 1967.
7) M.A. Wahab; Solid State Physics: Structure and Properties of Materials, Alpha Science International 2005.

M.Sc. I, Semester-II
Physics Lab-II (DSE-PR II)
DSC12PHY29
Mark: 150 (Credits 06)

1) Fourier analysis.
2) Transmission characteristics of passive filters.
3) I-V characteristics of solar cell.
4) A. C. bridges
5) Thermal diffusivity of brass.
6) Mutual inductance of given coil.
7) Series & parallel resonant LCR circuits.
8) Young's modulus of a beam by flexural vibration created by frequency generator.
9) 2-D and 3-D plots using Mathematica.
10) Band gap energy of semiconductor.
11) Resistivity of given semiconductor sample using four probe method.
12) Thermoelectric Power.
13) Magnetic field variation as a function of resonance frequency using ESR.
14) Crystal structure of thin film by using given XRD data.
15) Rydberg constant.
16) Dissociation energy of iodine molecule.
17) Magnetic susceptibility of ferric chloride solution.
18) Planck's constant using photocell.
19) Numerical solutions of simple first order differential equation using Python (Euler and Runge Kutta 4^{th} order method)
20) Plotting simple functions using Python.
21) Plotting of simple graphs using origin software.
22) Crystallite size by Debye- Scherrer Formula ($D=0.9\lambda/\beta \cos\theta$).

On Job Training/ Field Project

(Arrange on job training/Field project at CFC (4 credits) for all the students)

Vivekanand College, Kolhapur (Empowered Autonomous)

Nature of Question Paper

Theory: Time -3 hours, Marks-
80 Instructions: All questions are
compulsory.

Q.1 Select Correct Alternative **(8)**

1. …………………………………
   A) B) C) D)
2. …………………………………
   B) B) C) D)
3. …………………………………
   A) B) C) D)
4. …………………………………
   A) B) C) D)
5. …………………………………
   A) B) C) D)
6. …………………………………
   A) B) C) D)
7. …………………………………
   A) B) C) D)
8. …………………………………
   A) B) C) D)

Q.2 Attempt any four **(48)**

1…………………………………….
2……………………………………….
3……………………………………
4…………………………………….
5……………………………………….
6……………………………………

Q. 3 Attempt any four **(24)**

1…………………………………….
2……………………………………….
3……………………………………
4…………………………………….
5……………………………………….