"Education for Knowledge, Science and Culture"

- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

Accredited By NAAC with 'A' Grade

Department of Physics

Syllabus as per

NATIONAL EDUCATION POLICY (NEP-2020)

for

M.Sc. Part – I, Semester I & II

Physics

Syllabus to be implemented 2023-2024

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

Department of Physics

Structure and Credit Distribution for M. Sc. Program as per NEP – 2020

<table>
<tr><th>Year</th><th>Level</th><th>SEM</th><th colspan="2">Major</th><th>Minor</th><th>OJT/FP</th><th>RP</th><th>Cum Cr.</th><th>Degree</th></tr>
<tr><td></td><td></td><td></td><td>Mandatory</td><td>Elective</td><td rowspan="2">RM-PHY
(4)</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">22</td><td rowspan="3">PG Diploma (after 3 Yr Degree)</td></tr>
<tr><td rowspan="2">I</td><td>6</td><td>I</td><td>MP (4)
CM (4)
P-Lab- I (2)
P-Lab -II (2)
P-Lab -III (2)</td><td>SSP-1 (4 credit)</td></tr>
<tr><td>6</td><td>II</td><td>QM (4)
CMP (4)
P-Lab - IV (2)
P-Lab - V (2)
P-Lab -VI (2)</td><td>SSP-2 (4 credit)</td><td></td><td>FP-PHY
(4)</td><td></td><td>22</td></tr>
<tr><td colspan="3">Cum. Cr. PG Diploma</td><td>28</td><td>8</td><td>4</td><td>4</td><td></td><td>44</td><td></td></tr>
</table>

Exit option: PG Diploma (40-44 Credits) after three year UG Degree

II	6.5	III	SM (4) AMP (4) P-Lab - VII (2) P-Lab -VIII (2) P-Lab - IX (2)	SSP-3 (4 credit)			RP-PHY (4)	**22**	**PG Degree after 3-Yr UG or PG Degree after 4 -Yr UG**
		IV	ED (4) NP(4) ET (4)	SSP- 4 (4 credit)			RP-PHY (6)	**22**	
Cum. Cr. for 1 Yr PG Degree			**26**	**8**			**10**	**44**	
Cum. Cr. for 2 Yr PG			**54**	**16**	**4**	**4**	**10**	**88**	

Abbreviations: Yr: Year; Sem: Semester; OJT: On Job Training: Internship/Apprenticeship; FP: Field Projects; RM: Research Methodology; RP: Research Project; Cum. Cr.: Cumulative Credits; MP: Mathematical Physics; CM: Classical Mechanics; P-Lab- Practical Lab; QM: Quantum Physics; CMP: Condensed Matter Physics; SM: Statistical Mechanics; AMP: Atomic and Molecular Physics; ED: Electrodynamics; NP : Nuclear and Particle Physics; SSP: Solid State Physics.

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)
Department of Physics

Teaching and Evaluation scheme
Four/Five - Years PG Programme
Department/Subject Specific Core or Major (DSC)
M.Sc. - Physics
First Year 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	MIN-I	MIN12PHY11	Research Methodology	4	-	80	20	-	100	4
4	OEC-I	OEC12PHY11	Solid State Physics-I	4		80	20	-	100	4
5	DSC-PR-I	DSC12PHY19	Practical Lab - I	-	2	-	-	50	50	2
6	DSC-PR-II	DSC12PHY19	Practical Lab - II	-	2	-	-	50	50	2
7	DSC-PR-III	DSC12PHY19	Practical Lab - III	-	2	-	-	50	50	2
								Total	**550**	**22**
Semester-II										
1	DSC-III	DSC12PHY21	Quantum Mechanics	4	-	80	20	-	100	4
2	DSC-IV	DSC12PHY22	Condensed Matter Physics	4	-	80	20	-	100	4
3	OEC -II	OEC12PHY21	Solid State Physics-II	4	-	80	20	-	100	2
4	FP-I	FP12PHY21	Field Project	-	4			-	100	4
5	DSC-PR-IV	DSC12PHY29	Practical Lab - IV	-	2	-	-	50	50	2
6	DSC-PR-V	DSC12PHY29	Practical Lab - V	-	2	-	-	50	50	2
7	DSC-PR-VI	DSC12PHY29	Practical Lab - VI	-	2	-	-	50	50	2
								Total	**550**	**22**

Semester III										
1	DSC-V	DSC12PHY31	Statistical Mechanics	4	-	80	20	-	100	4
2	DSC-VI	DSC12PHY32	Atomic and Molecular Physics	4	-	80	20	-	100	4
3	OEC -III	OEC12PHY31	Solid State Physics-III	4	-	80	20	--	100	**4**
4	RP-I	RP12PHY39	Research Project	-	4	-	-	100	100	**4**
5	DSC-PR-VII	DSC12PHY39	Practical Lab - VII	-	2	-	-	50	50	2
6	DSC-PR-VIII	DSC12PHY39	Practical Lab - VIII	-	2	-	-	50	50	**2**
7	DSC-PR-IX	DSC12PHY39	Practical Lab - IX	-	2	-	-	50	50	**2**
								Total	**550**	**22**
Semester IV										
	DSC-VII	DSC12PHY41	Electrodynamics	4	-	80	20	-	100	**4**
	DSC-VIII	DSC12PHY42	Nuclear and Particle Physics	4	-	80	20	-	100	**4**
	DSC-IX	DSC12PHY43	Experimental Techniques	4	-	80	20	-	100	**4**
	OEC -IV	OEC12PHY41	Solid State Physics-IV	4	-	80	20	-	100	**4**
	RP-II	RP12PHY49	Research Project	-	6	-	-	150	150	**6**
								Total	**550**	**22**
	Total								**2200**	**88**

Abrr. TH-Theory, PR-Practical, ESE- End Semester Examination, CIE-Continuous Internal Examination

Note: Minimum passing for 80 marks Theory paper = 32 marks

Minimum passing for 20 marks Internal evaluation = 8 marks

Minimum passing for 50 marks Practical/FP/OJT/RP = 18 marks

Minimum passing for 150 marks Practical/FP/OJT/RP =50 marks

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

Department of Physics

M. Sc.

Mapping of PO's and PSO's

After successful completion of two year degree program in physics a student should be able to,

Program Outcomes (POs)

PO -1) The student will acquire a job efficiently in diverse fields such as Science and Engineering, Industry, Education, Banking, Public Services, Business.

PO- 2) The student will effectively communicate their knowledge of physics through a variety oforal, written, and computational modalities.

PO -3) The student will be able demonstrate a purposeful knowledge of scientific literature andethical issues related to physics.

PO -4) Describe and critically evaluate the current state-of-the-art in solid state Physics area.

PO-5) 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.

PO-6). Understand good laboratory practices and safety.

Program Specific Outcomes (PSO`s)

PSO-1) 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 coreand specialized physics papers

PSO-2) 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/equipments.
- 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 extendedexperimental or theoretical Physics based on project in Masters Programme.
- Demonstrate, solve and an understanding of major concepts in all disciplines ofPhysics

PSO-3) Understand and apply principles of physics for understanding the scientific phenomenonin classical and quantum physics.

PSO-4) The student will become effective researcher who will be able to publish scientific papers, articles on a given topic of study.

PSO-5) Student will be gain knowledge to continue research at the higher degree (PhD) level.

PSO-6) Enhance student's ability to develop mathematical models for physical systems

M. Sc. - I
Semester-I

M.Sc. (Physics) NEP-Semester-I
Course Code: DSC12PHY11
Paper title: Mathematical Physics (MP)
Total Credits: 4-credits

Course Outcomes: Mathematical Physics

After the completion of course, the student could able to:

CO-1) Well-versed with the Matrices.

CO-2) Understand the elementary ideas and have acquired facility with numerical tools forsolving mathematical problems in Complex Variables.

CO-3) can understand the complications associated with the Fourier Series and Transform

CO-4) Learn about the concept of some special functions, Frobenius power series and polynomials

Mathematical Physics

Unit 1. Matrices [15]

Matrix multiplication – Inner product, direct product, Diagonal matrices, trace, matrix Inversion, Gauss-Jordon Inversion, Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors, Cayley-Hamilton Theorem and applications, similar matrices and diagonalizable Matrices, functions of matrices, Quadratics forms.

Unit 2. Complex Variables [15]

Limits and continuity of complex functions, Derivatives and analytic functions, Cauchy- Riemann conditions, Line integrals in the complex plane, Cauchy Integral theorem and Cauchy integral formulas, Singularities- Poles, Branch Points, Calculus of Residues-Residues Theorem, Cauchy Principle value, Pole Expansion of Meromorphic Functions, Product expansion of entire functions.

Unit 3. Fourier Series and Transform [15]

Definition, Evaluation of Coefficients of Fourier Series (Cosine and Sine Series), Dirichelet's Theorem, Graphical representation of a square wave function, Extension of interval, Complex form of Fourier Series, Properties of Fourier Series (Conversions, Integration, Differentiation, Parseval's Theorem), Fourier Integral- exponential form, Applications of Fourier Series analysis in Physics (Square wave, Full wave rectifier, Expansion of Raman Zeta function).

Unite 4. Special Functions [15]

Frobenius power series method, Legendre differential equation (Rodrigues' formula for Legendre polynomials, generating function, Orthogonality of Legendre polynomials), Hermite differential equation (Rodrigues' formula for Hermite polynomials, generating function, Orthogonality of Hermite polynomials), Laguerre differential equation ((Rodrigues' formula for Laguerre polynomials, generating function, Orthogonality of Laguerre polynomials)

References:

- Mathematical Methods, H.K. Das
- Mathematical Methods, Rajput
- Mathematical Methods for Physicists, Arfken and Weber
- Mathematical Methods for Physicists, Tai Chow

M.Sc. (Physics) NEP -Semester-I
Course Code: DSC12PHY12
Paper title: Classical Mechanics (CM)
Total Credits: 4-credits

Course outcomes: Classical Mechanics

After the completion of course, students will attain

CO-1). Understanding of Mechanics and Lagrange's and Hamilton's theory.

CO-2) Gain basic knowledge of Canonical Transformation and Special Relativity and the evolutionary significance of it.

CO-3) Learn about the concept of canonical transformation, coupled oscillations

CO-4) Able to solve problems regarding classical mechanics

Classical Mechanics

Unit-I- Mechanics **(15)**

Mechanics of a system of particles in vector form. Conservation of linear momentum, energy and angular momentum. Degrees of freedom, generalized coordinates and velocities. Lagrangian, action principle, external action, Euler-Lagrange equations. Constraints. Applications of the Lagrangian formalism. Generalised momenta, . Legendre transform, relation to Lagrangian formalism. Phase space, Phase trajectories. Applications to systems with one and two degrees of freedom.

Unit-II-Lagrange's and Hamilton's theory: **(15)**

Configuration space, techniques of calculus of variation, Applications of the variationalprinciple. Hamiltonian principle, Equivalence of Lagrange's and Newton's Equations,Lagrange's Equation for non-Holonomic systems, Hamilton's equations of motion, Hamilton'sapplications-Simple pendulum, Charged particle in an electromagnetic field.

Unit-III-Canonical Transformation; **(15)**

Guge transformation, Canonical transformation- it's conditions and illustration. Poisson Bracket-canonical equations in terms of Poisson bracket notation, Hamiltonian Jacobi Equations, Separation of Variables-Kepler's problem: solution by Hamilton-Jacobi method. Examples.

Unit-IV- Special Relativity: **(15)**

Review of Frame of reference, and Newtonian relativity, Gallelian transformation equation, Principal and postulates of special theory of relativity, Lorentz transformation equations, Length contraction, Time dilation, Relativity of simultaneity, Addition of velocities, Variation of mass with velocity, Mass energy equivalence, Minkowskis four dimensional space time continuum, Energy-momentum four-vector for a particle. Relativistic invariance of physical laws. Gravitational Red shift,

References:

Introduction to classical mechanics-R.G.Takwale and P.S.Puranik
Classical Mechanics, by H Goldstein (Addison Wesley 1980).
Classical Mechanics, by J.C. Upadhyaya (Himalaya Publishing House 2015).
Classical Mechanics, by N C Rana and P S Joag (Tata McGraw Hill 1991).
Classical Mechanics, by Gupta, Kumar and Sharma (Pragati Prakashan 2000).
Classical mechanics-J.C. Upadhyaya.7, Classical Mechanics-Gupta, Kumar.

M.Sc. (Physics) NEP -Semester-I
Course Code: MIN12PHY11
Paper title: Research Methodology (RM)
Total Credits: 4-credits

Course Outcomes: Research Methodology

After the completion of course, the student could able to:

CO-1) Understand the meaning of research, research design

CO-2) Understand the methods of data collection

CO-3) students will learn about various tool of literature survey

CO-4) Learn about Thin film deposition technics and also learn how to study properties and analysis of thin films

Research Methodology

Unit 1 Research Methodology: (15)

a) 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.

b) Research design: meaning of research design, features of good design, important concepts of relating research design, different basic designs.

c) 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.

Unit 2 Literature Searching and Report Writing: (15)

a) Literature Searching: On-line searching, Database, SciFinder, Scopus, Science Direct, CA on CD, Searching research articles, Citation Index, Impact Factor, H-index etc.,

b) 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.

c) Thesis writing: the preliminary pages and the introduction, the literature review, methodology, the data analysis chapters, the conclusion

Unit 3: Thin film deposition: Physical methods (15)

Vacuum deposition apparatus: Vacuum systems, substrate materials, Thermal Evaporation methods: Resistive heating, laser evaporation, electron bombardment heating, Sputtering: sputtering variants, glow discharge sputtering, RF Sputtering, Ion beam sputtering

Unit 4: Properties and characterization of thin films (15)

Mechanical properties of thin films: Introduction to elasticity, plasticity, and mechanical behavior, Electrical and magnetic properties of thin films, Optical properties of thin films, Structural characterization: X-ray diffraction, Scanning electron microscopy, Transmission electron spectroscopy,

chemical characterization: X-ray Energy Dispersive Analysis (EDX), X-ray, photoelectron spectroscopy (XPS).

Reference Books

- 1.Fundamentals of computers, Morley & Parkar, Cengage Learning Pvt. Ltd. New Delhi,
- 2.Research Methodology – Methods and Techniques, C. R. Kothari, Wiley Easter Ltd, New Delhi
- 1985.
- Writing your thesis, Paul Oliver, Vistaar Publication, New Delhi
- Thin Film Phenomena by K L Chopra McGraw -Hill Book Company, NY 1969
- The Materials Science of Thin Films by Milton Ohring, Academic Press, (1992) (unit4)

Elective Paper

Sr. No.	Course Code	Paper Title
1	OEC12PHY11	SSP-1 (Semiconductor Physics) (4 credits)

M.Sc. (Physics) NEP Semester-I
Course Code: OEC12PHY11
Paper title: SSP-I (Semiconductor Physics)
Total Credits: 4-credits

Course Outcomes: Solid State Physics-I (Semiconductor Physics)

At the end of the course, students will be able to,

CO-1) A critical and systematic understanding of energy bands and charge carriers in Semiconductors.
CO-2) Learn the basics of excess carriers in semiconductors, Optical absorption, Luminescence, diffusion and drift of carriers.
CO-3) Provide a broad view of fabrication of p-n junctions and current flow through at a junction, Capacitance of p-n junctions, heterojunction.
CO-4) Understand the concepts of solar photovoltaics

Solid State Physics-1
(Semiconductor Physics)

UNIT I : Energy Bands and Charge Carriers in Semiconductors: (15)

Bonding forces and energy bands in solids, Direct and Indirect semiconductors, variation ofenergy bands with alloy composition, Charge carriers in semiconductors: electrons andholes, effective mass, intrinsic and extrinsic materials, electrons and holes in quantum wells, TheFermi level, carrier concentration at equilibrium, temperature dependence, space chargeneutrality, conductivity and mobility, Drift and resistance, effects of temperature and doping onmobility, High field effects.

UNIT II: Excess Carriers in Semiconductors: (15)

Optical absorption, Luminescence, 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, The Haynes-Shockley experiment.

UNIT III: PN Junction (15)

Fabrication of p-n junctions; Thermal oxidation, diffusion, Rapid thermal processing, Ion implantation, CVD, Photolithography, etching, metallization, The contact potential, Spacecharge at a junction, qualitative description of current flow at a junction, reverse-bias breakdown,Zener and Avalanche breakdown.

UNIT IV: Solar Photovoltics **(15)**

P-N junction under illumination, Light generated current, I-V equation, Characteristics, Upper limits of cell parameters, losses in solar cells, equivalent circuit, effects of various parameters on efficiency, Solar cell design, Design for high Isc, Antireflective coating (ARC), Design for high Voc and fill factor

Reference Books

- Solid state electronic devices by B. G. Streetman.
- Physics of semiconductor devices by S. M. Sze.
- Solid State and Semiconductor Physics by McKelvey.
- Principles of Elecronic Materials and Devices by S.O. Kasap

M. Sc. I (Physics) NEP- Semester I
Course Code: DSC12PHY19
Paper title: Physics LAB-I to III
Total Credits: 6-credits

Laboratory/ Practical Course

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.

M. Sc. - I
Semester-II

M.Sc. (Physics) NEP-Semester-II
Course Code: DSC12PHY21
Paper title: Quantum Mechanics
Total Credits: 4-credits

Course Outcomes: Quantum Mechanics

At the end of the course, students will be able to,
CO-1) Students would understand basic concepts in the Origin and general formalism andrepresentation of states and quantum dynamics.
CO-2) Students develop theoretical knowledge of Angular Momentum operator
CO-3) Students develop important basic understanding about time independent perturbationtheory, and its applications.
CO-4) Students develop important basic understanding angular momentum, operators, approximation method etc.

Quantum Mechanics

Unit 1 : Origin and general formalism (15)

Sequential Stern-Gerlach experiment, analogy with polarization of light, linear vector space, linear operator, eigenfunction and eigen values, Hermitian operator, Postulates of quantum mechanics , Diracs bra and ket notation, equation of motion, schrodinger representation, Heisenberg representation, momentum representation.

Unit-2: Angular Momentum (15)

Angular momentum operator, angular momentum commutation relations, Eigen values of J^2 & JZ, angular momentum matrices, spin angular momentum , addition of angular momenta, computation of clebsch- Gorden coefficients in simple cases(J_1=1/2, J_2=1/2)

Unit 3 : Time Dependent Perturbation Theory (15)

Time dependent potentials, Time dependent Perturbation theory, Applications to interactions with the classical radiation field, energy shift and decay width, Adiabatic Approximation.

Unit 4 : Scattering Theory (15)

The Lippmann-Schwinger equation, The Born approximation, Optical Theorem, Eikonal approximation, Free particle states, Partial wave formalism, Low energy scattering and bound states, Resonances, Scattering of identical particles, Symmetries in scattering, Time-dependent formulation of scattering, Inelastic electron-atom scattering, Coulomb scattering.

Reference Books:

- 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).
- Introduction to Quantum Mechanics, David J. Griffiths, Pearson Education, 2nd Edition (2015).
- Quantum Mechanics: Theory and Applications, Ajoy Ghatak and S. Lokanathan, Macmillan
- Publishers India, Fifth Edition (2004).
- Modern Quantum Mechanics, J. J. Sakurai and Jim J. Napolitano, Pearson Education India, 2nd
- Edition, (2013).

M.Sc. (Physics) NEP-Semester-II
Course Code: DSC12PHY22
Paper title: Condensed Matter Physics
Total Credits: 4-credits

Course Outcomes: Condensed Matter Physics

At the end of the course, students will be able to,

CO-1) Understand and describe various crystal structures in crystallography.

CO-2) Describe and understand fundamental concepts of crystal defects.

CO-3) Discuss different aspects of Dielectric, Magnetism & Superconductivity.

CO-4) Assess and critique Semiconductor theory , semiconductor materials, which will eventually lead to a general framework of concepts applicable across a variety of semiconductordevices.

Condensed Matter Physics

Unit-I: Crystallography: (15)

Bonding in Solids-Ionic, Covalent and Metallic. Crystalline state of solids, Bravai's lattices and crystal structure , Symmetry elements(cubic),coordination number and packing fraction. Crystal structures-CsCl, ZnS, and diamond, Brag's law in reciprocal lattice, Brillouin zones, Comparison between X-Ray, Electron and Neutron diffraction, Field ion microscopy-Principal, working and applications

Unit-II: Crystal defects: (15)

Point defects-Vacancies, Interstitials, impurities, electronic, Expression for Schottky and Frenkel defects Line defects-Edge and screw dislocation, Interpretation of SGP (Plastic deformation) Burgur's vector and circuit, Frank-Read mechanism. Planer defects, Surface defects- Grain boundaries, Tilt boundaries, Twin boundaries, Effect of Imperfections

Unit-III Dielectric, Magnetism & Supercondivity: (15)

Dielectric-Polarisation mechanism, Dielectric constant, Clausis-Mossoti relation, Magnetism-Comparison between dia, Para, and ferromagnetism ,Exchange interaction. Magnetic order (Fero, Antifero and ferri), Weiss theory of magnetism Superconductivity- High Tc superconductors, BCS theory of superconductors, SQUID

Unit-IV Semiconductor theory and devices: (15)

Energy band gap, Determination of Band gap energy, intrinsic and extrinsic semiconductors, carrier concentration, fermi level and conductivity for intrinsic and extrinsic semiconductor. Review of UJT, switching characteristics of UJT, SCR- construction and working, switching characteristics.

Reference Books:

- Introduction to solid state physics - C. Kittel, 8thedn, John Wiley & Sons. Inc., NewYork (1976).
- Solid state physics by A. J. Dekker, MacMillan India Ltd. (1986).
- Solid state physics - N. W. Ashcroft and N. D. Mermin, HRW International edn.(1976).
- Solid state physics – S. O. Pillai. New Age International Publication.-2002
- Solid State Physics - H. C. Gupta- Vikas Publishing House, New Delhi-2002
- Electronic Properties of Materials- R. E. Humel, 2ndedn. Springer International(1994)
- Solid State Physics – J. S. Blakemore, 2ndedn. Cambridge University Press(1985)
- Solid State Physics-R.K.Puri, V.K.Babar- S.Chand.

Elective Paper

Sr. No.	Course Code	Paper Title
1	OEC12PHY21	SSP-2 (Semiconductor Devices) (4 credits)

M.Sc. (Physics) NEP Semester-II
Course Code: OEC12PHY21
Paper Title: Solid State Physics-II (Semiconductor Devices)
Total Credits: 4-credits

Course Outcomes: Solid State Physics-II (Semiconductor Devices)

At the end of the course, students will be able to,

CO-1) Understand the working ,structure and operation and functions of (BJT), (JFET), MOSFET, MESFET, and diodes.

CO-2) Identify the problems and applications of Magneto-optic and acousto-optic, Piezoelectric, Electrostrictive and magnetostrictive effects.

CO-3) Acquire basic knowledge about Light emitting Diodes, OLED, Infrared LED, Photodetector, Photoconductor, Photodiode, p-n junction Solar cells, Semiconductor Lasers

CO-4) Learn the techniques of Thermistor, and sensors.

Solid State Physics-2
(Semiconductor Devices)

Unit 1 Transistors and Microwave Devices: **(15)** Bipolar junction transistor (BJT), frequency response and switching of BJT, Field effecttransistor (JFET), MOSFET and related devices, MESFET device structure and itsoperation, Tunnel diode, transferred electron devices and Gunn diode, Avalanche transit timediode and IMPATT diode.

Unit 2 Photonic Devices: **(15)**
Radiative transitions and optical absorption, Light emitting Diodes, OLED, Infrared LED, Photodetector, Photoconductor, Photodiode, p-n junction Solar cells, Conversion efficiency, Semiconductor Lasers, Laser operation, population inversion, carrier and optical confinement, optical cavity.

Unit 3 Other electronic Devices: **(15)**
Magneto-optic and acousto-optic effects, Material's properties related to get these effects, Piezoelectric, Electrostrictive and magnetostrictive effects, important materials, exhibiting these properties and their applications in sensors and actuator devices.

Unit 4 Sensors: **(15)**

Thermal sensors-Thermistor, transistor thermal sensor, no semiconductor sensors, thermocouple, Mechanical sensors- strain gauge, Magnetic sensors-capacitive sensor-Hall plate, Magnetoresistor, Magnetotransistor, Chemical Sensors- Metal- Oxide Sensors, Bio sensors

Reference Books:

- Semiconductor devices: Physics and Technology 2nd Edition, S. M. Sze
- Modern Digital Electronics, R. P. Jain
- Introduction to Semiconductor devices by M. S. Tyagi
- Optical electronics by Ajoy Ghatak and K. Thyagrajan, Cambridge University Press.

M.Sc. (Physics) NEP-Semester-II
Course Code: FP12PHY21
Paper title: Field Project
Total Credits: 4-credits

On Job Training/ Field Project

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

M.Sc. (Physics) NEP -Semester-II
Course Code: DSC12PHY29
Paper title: Physics LAB-IV to VI
Total Credits: 6-credits

Laboratory/ Practical Course- III

1. Fourier analysis.
2. Transmission characteristics of passive filters.
3. I-V characteristics of solar cell.
4. A. C. bridges (Maxwell, Anderson and De-Sauty bridge)
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. 2D and 3D 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. Plank'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 ($D=0.9\lambda/\beta \cos\theta$).

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. ……
   C) B) C) D)
4. ……
   D) B) C) D)
5. ……
   E) B) C) D)
6. ……
   F) B) C) D)
7. ……
   G) B) C) D)
8. ……
   H) 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……
6……