PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

NAAC Accredited-2022
'B^{++}' Grade (CGPA 2.96)

Name of the Faculty: Science & Technology

As Per NEP-2020

Syllabus: PHYSICS

(Applied Electronics / Materials Science/Energy Studies/ Solid State/ Nanophysics)

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

(Syllabus to be implemented from June 2023)

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY

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

1) **Title of the course:** M.Sc. in Physics (Applied Electronics/Materials Science/Energy Studies/ Solid State/ Nanophysics)
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 88 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	Marks	Credits
Semester I			
• Theory Papers	04	400	16
• Practical Papers	03	150	06
Semester II			
• Theory Papers	03	300	12
• Practical Papers	03	150	06
• On Job Training / Field Project	01	100	04
Semester III			
• Theory papers	03	300	12
• Practical Papers	03	150	06
• Research Project	01	100	04
Semester IV			
• Theory papers	03	300	12
• Practical Papers	02	100	04
• Research Project	01	150	06
Total marks and credits for M.Sc. Course		**2200**	**88**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

M. Sc. Physics Choice Based Credit System (CBCS)

Course Structure

M.Sc. Part-I Physics (Applied Electronics/ Materials Science/ Energy Studies/ Solid State / Nanophysics) w.e.f. 2023-24

M.Sc. Physics, Semester -I							
Paper Code	**Title of the Paper**	**Semester Examination**			**L**	**P**	**Credits**
		UA	**CA**	**Total**			
DSC-1	Mathematical Physics	80	20	100	4	--	4
DSC-2	Solid State Physics	80	20	100	4	--	4
DSE-1A	Analog and Digital Electronics	80	20	100	4	--	4
DSE-1B	Elements of Materials Science						
RM	Research Methodology in Physics	80	20	100	4	--	4
Lab 1	Practical-1: (Based on DSC1)	40	10	50	--	2	2
Lab 2	Practical-2: (Based on DSC2)	40	10	50	--	2	2
Lab 3	Practical-3: (Based on DSE1)	40	10	50	--	2	2
Total for Semester-I		**440**	**110**	**550**	**16**	**6**	**22**

M.Sc. Physics, Semester -II							
Code	**Title of the Paper**	**Semester Examination**			**L**	**P**	**Credits**
		UA	**CA**	**Total**			
DSC-3	Quantum Mechanics	80	20	100	4	--	4
DSC-4	Electrodynamics	80	20	100	4	--	4
DSE-2A	Classical Mechanics	80	20	100	4	--	4
DSE-2B	Conventional & Non conventional Energy						
OJT/FP	OJT/FP	80	20	100	--	4	4

Lab 4	Practical-4: (Based on DSC3)	40	10	50	--	2	2
Lab 5	Practical-5: (Based on DSC4)	40	10	50	--	2	2
Lab 6	Practical-6: (Based on DSE2)	40	10	50	--	2	2
Total for Semester-II		**440**	**110**	**550**	**12**	**10**	**22**

DSC: Discipline Specific Course

DSE: Discipline Specific Elective

OJT: On Job Training: Internship/ Apprenticeship

FP: Field projects:

RM: Research Methodology

RP: Research Project:

Evaluation Scheme:

Each theory paper (DSC/DSE) will have 100 marks out of which 80 marks will be for Term End examination and 20 marks for Internal Assessment. The candidate must 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. i.e (40 UA+10 CA). Research Methodology is of 100 Marks (80 UA+20 CA).

The candidate must 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 (DSC/DSE/RM) is of 80 marks of 3 hours duration.

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 per Lab and is of two hours duration. VIVA will be for 10 marks per Lab.

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M. Sc.- I, SEM- I, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSC-1: MATHEMATICAL PHYSICS

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course Objectives:

The purpose of the course is to introduce students to methods of mathematical physics and to develop required mathematical skills to solve problems in quantum mechanics, electrodynamics and other fields of theoretical physics. Mathematical technique is an important tool that every physicist would like to utilize.

Upon completion of the course, the student should be able to understand basic theory of:

- Operator and Matrix Analysis
- Functions of complex variables
- Elements of distribution theory
- Fourier series

Learning Outcomes: Successful students should be able to:

- Apply methods of functions of complex variables for calculations of integrals
- Expand functions in Fourier series
- Work with vectors
- Work with Operators
- Work with Integral Transforms

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, SEM- I, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State/ Nanophysics)

DSC-2: Solid State Physics

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course objectives:

The course offers an introduction to solid state physics, and will allow the student to employ classical and quantum mechanical theories needed to understand the physical properties of solids. Prominence is put on building models able to explain several different phenomena in the solid state.

The course carries an understanding of how solid-state physics has contributed to the existence of several important technological developments of importance in our lives now and in the future.

Learning outcomes:

The student can---

- Understand mechanical properties of matter, and connect these to bond type.
- Understand how diffraction of electromagnetic waves on solid matter can be used to obtain lattice structure.
- Understand simple theories for conduction of heat and electrical current in metals.
- Classify solid state matter according to their band gaps.
- Understand how electrons and holes behave in semiconductors, and explain how they conduct current.
- Understand simple models for dielectrics.
- Understand the basic physics behind superconductors

Unit I: Band Theory of Solids **(15)**

Nearly free electron model, DC and AC electrical conductivity of metals. Bloch theorem (with proof), Kronig-Penney model, Motion of electron in 1-D according to band theory, Distinction between metals, insulators and intrinsic semiconductors, Brillion zones,

Ref. 1: Ch. 7 and 9

Unit II: Diamagnetism and Paramagnetism **(15)**

Classical theory of diamagnetism, Langevin theory of Paramagnetism, Weiss theory of Paramagnetism, Paramagnetic susceptibility of a solid.

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

Ref. 1: Ch. 14

Unit III: Ferromagnetism, Antiferromagnetism and Ferrimagnetism **(15)**

Ferromagnetism: Wiess theory, Curie point, Exchange integral, saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, ferromagnetic domains, Anisotropy energy, Bloch wall, Antiferromagnetism: Neel temperature, Ferrimagnetism: Curie temperature, susceptibility of ferrimagnets.

Ref. 1: Ch 15

Unit IV: Superconductivity **(15)**

Occurrence of superconductivity, Meissner effect, Heat capacity, Energy gap, Microwave and IR properties, Isotope effect, Type I and II superconductors, Thermodynamics of superconductivity, London equation, London penetration depth, BCS theory, Josephson tunneling and its theory.

Ref. 1: Ch.12

Reference Books:

1. Introduction to solid states Physics - Charles, Kittle 7th Edition

2. Introductory Solid States Physics – H. P. Myers

3. Solid States Physics - S.O. Pillai (latest edition)

4. Elementary Solid States Physics- M. Ali Omar

5. Problem in Solid State Physics – S.O. Pillai

6. Solid States Physics – A.J. Dekkar

7. Solid states Physics – Wahab

8. Solid State Physics: Neil W. Ashcroft, N. David Mermin

9. Solid States Physics – Ibach & Luth

10. Solid States Physics – C.M.Kacchaw

M.Sc-I, SEM- I, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSE-1A: ANALOG & DIGITAL ELECTRONICS

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course Objectives:

- To understand the fundamentals analog and digital electronics.
- To understand the differential amplifier and its types.
- To understand the building blocks of operational amplifiers 741, characteristics, parameters.
- To understand applications of operational amplifiers as multivibrators, Instrumentation amplifier, comparators, voltage regulator, power supplies.
- To understand the digital devices like flip flops, MUX and DEMUX, shift registers, counters
- To understand the architecture, instruction set and different modes of addressing of 8085 microprocessor.

Learning Outcomes:

After completion of this course, the students should be able

- To design analog circuits using Op amp 741.
- To design digital circuits using combinational sequential logic.
- To write the simple assembly language programs using microprocessor.

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.

Ref.1 ,2

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.

Ref.1 ,2

Unit III: Combinational & Sequential Logic Circuits (15)

Combinational logic:

The transistor as a switch, OR AND NOT gates- NOR And NAND gates Boolean algebra- Demorgan's 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.

Ref. 3 ,4,5

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) .

Ref. 6

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, SEM- I, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSE-1B: ELEMENTS OF MATERIALS SCIENCE

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

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-vizpolyethylene. 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, SEM- I, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

RM: Research Methodology in Physics

4 Credits, Marks 100 (80 UA + 20 CA)

Learning / Course Objectives: At the end of this course a candidate will be able to –

1. Understand the psychology of research which includes different perspectives and necessity of research.
2. Analyze the research outcome by using suitable statistical tool.
3. Understand various research methodology for growth of nanomaterials
4. Understand various microscopy techniques

Unit-I – Introduction to Research (15)

Scientific Research- Meaning and importance of Research – Types of Research, Selection and formulation of Research Problem – Research Design Motivation and objectives.

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem.

Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web Critical literature review – Identifying gap areas from literature review.

Research methods vs Methodology- Types of research – Descriptive vs. Analytical, Applied vs Fundamental, Quantitative vs. Qualitative, Conceptual vs Empirical, development of working hypothesis.

Unit-II– Research Methodology in Physics (15)

Overview of research methodology in Physics, Scientific problem formulation & solving.

Execution of the research, Observation and Collection of data, Data interpretation and analysis, Precision and accuracy, Error analysis, Diagrammatic & graphical presentation of data, sampling methods, tools & software, Data Processing and analysis strategies, data analysis with statistical tools.

Unit-III – Growth Techniques of Nanomaterials **(15)**

Physical Methods: Physical vapor deposition-thermal evaporation, e-beam evaporation, Sputtering-Basics and mechanism, different types of sputtering techniques (DC, RF, Magnetron and Ion Beam), Pulsed Laser deposition,

Chemical Methods: Chemical vapor deposition, Chemical bath deposition, Sol-gel, Electrodeposition, Spray pyrolysis.

Unit-IV- Microscopy Techniques

Optical microscopy (UV-Visible, FTIR), Scanning Probe Microscopy (SEM, TEM, HRTEM, AFM, STM),

Reference Books:

1. An introduction to Research Methodology; Garg B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002., RBSA Publishers.
2. Research Methodology: Methods and Techniques, Kothari C.R., 1990. New Age International.
3. Research Methodology; Sinha S.C. and Dhiman, A.K., 2002. Ess Publications. 2 volumes.
4. Research Methods: the concise knowledge base; Trochim W.M.K., 2005. Atomic Dog Publishing. 270p.
5. Research Methodology; Panneerselvam R., PHI, Learning Pvt. Ltd., New Delhi - 2009 6. Research Methodology: Concepts and cases, Chawala D. and N. Sondhi ; Vikas Publishing House Pvt. Ltd.
6. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay, A.N. Banerjee, PHI, Publisher

M. Sc.- I, SEM- I, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

Practical: 1, 2, 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. Astable Multivibrator (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. Astable Multivibrator (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.

M.Sc-I, SEM- II, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSC-3: QUANTUM MECHANICS

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course Objectives:

- To study the fundamental postulates of quantum mechanics and to apply them for microscopic bodies.
- To review the relevant concepts in classical physics before corresponding concepts are developed in quantum mechanics.
- To provide an understanding of the power and elegance of quantum mechanics.

Learning Outcomes:

- Provides a qualitative description of the remarkable concepts of quantum mechanics such as de-Broglie theory, Heisenberg uncertainty principle, Schrodinger equation, operators, etc.
- Students can gain the idea of applying these concepts to simple systems such as 1D box, 1D harmonic oscillator, hydrogen like atoms and many electron systems as helium atom etc.
- The complete Born-Oppenheimer approximation and Hartee-Fock theories gives the students some understanding of the molecular orbital as well as the current methods of performing electronic structure calculation.
- The problems solved during the course will be helpful for SET/NET.

Unit I: Operator Formalism **(15)**

Linear Vector Spaces, Scalar Product, Schwartz Inequality, State Vector, difference between span and basis, orthogonal and orthonormal, General formalism of operator mechanics, operator algebra, commutation relations, Hermitian operator definition and properties, Relation between non commutativity of two operators and uncertainty relation, Dirac's bra-ket notations, Matrix representation of operators, state vector and scalar product. Effect of change of basis on the matrix representation, Unitary transformation.

Unit II: Introductory Quantum Mechanics (15)

Time dependent and time-independent Schrodinger equation, Interpretation of wave function, admissible wave functions, continuity equation, Operators, Expectation Value, Ehrenfest's theorem, Uncertainty Principle, wave packet, admissible wave functions, stationary states, postulates of quantum mechanics, Eigen Values and Eigen Vectors. Momentum Eigen function in the coordinate representation, box normalization and Dirac Delta function. Coordinate and Momentum representations, Schrodinger equation in momentum representation. Quantum Dynamics: Schrödinger, Heisenberg and Interaction picture.

Unit III: Solution of Schrodinger equation for some solvable systems and Angular Momentum Algebra (15)

Infinite and finite potential wells, Square Well potential and Nanoscience, Harmonic Oscillator by operator method, Schrodinger in spherical polar coordinate and its solution for hydrogen atom, Angular momentum algebra: Definition, Commutation relations, Simultaneous eigen function of $L^2$and L_z operator.

Unit IV: Addition of Angular Momenta and approximation methods (15)

Algebra of Spin angular momenta, Pauli Spin matrices, generalized angular momentum, matrices for J^2, J_x, J_y and J_z operators, Clebich Gordon Coefficient: Construction Procedure and simple examples.

Introduction to approximation methods like Variational and WKB methods with simple examples.

Reference Books

1. Introductory Quantum Mechanics (3rd Edition), D. J. Griffiths and D F Schroeter (Cambridge Univ. Press).
2. Quantum Mechanics-Theory and Applications by Ajoy Ghatak, S. Loknathan (Sixth Edition) Publisher TRINITY
3. Introductory Quantum Mechanics by Liboff (4th Edition), Publisher Pearson
4. Quantum Mechanics Concepts and Applications by Nouredine Zettili, John Wiley and Sons (second Edition)
5. Quantum Mechanics - LI. Schiff (McGraw-Hill).
6. A textbook of Quantum Mechanics - P M Mathews, K Venkatesan. (Tata McGraw Hill).

7. Concept of Modern Physics (6th Edi.) A Beiser, S Mahajan and S R Choudhury. (McGraw-Hill).

M. Sc.- I, SEM- II, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSC-4: ELECTRODYNAMICS

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course Objectives:

This course develops concepts in electric field and scalar potential, magnetic field and vector potential, Maxwell's equations, electromagnetic boundary conditions, electromagnetic wave equation, waveguides, energy in electromagnetism. Electromagnetic wave propagation in vacuum, conducting and dielectric media, and at interfaces.

Learning outcomes:

Students will have achieved the ability to:

- use Maxwell equations in analysing the electromagnetic field due to time varying charge and current distribution.
- describe the nature of electromagnetic wave and its propagation through different media and interfaces.
- explain charged particle dynamics and radiation from localized time varying electromagnetic sources.

Unit I: Electrostatics and Magnetostatics (15)

Gauss's law and applications, Differential form of Gauss's law, Poisson and Laplace's equations, Electrostatic potential energy, Boundary conditions, Uniqueness theorems, Biot-Savart law, Ampere's law, Differential form of Ampere's law, Vector potential, Magnetic field of a localized current distribution, Boundary conditions.

Unit II: Time varying fields and Energy, force, momentum relations (15)

Faraday's law, Maxwell's displacement current, Maxwell's equations, Maxwell's equations in matter, Scalar and vector potentials, 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.

Unit III: Electromagnetic wave equations (15)

Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Normal and Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth.

Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator.

Unit IV: Radiation emission (15)

Electric dipole, electric quadrupole and magnetic dipole radiation, Radiation by a moving charge: Lienard-Wiechert potentials of a point charge, Larmor's formula, Angular distribution of radiation. Fields and radiation of a localized oscillating source, radiation from a half wave antenna, radiation damping.

Reference Books

1. Introduction to Electrodynamics: David Griffiths (PHI)
2. Electrodyanamics J. D. Jackson
3. Introduction to Electrodynamics, A. Z. Capri and P. V. Panat (Narosa)
4. Classical theory of fields, Landau & Lifshitz
5. Electrodynamics, W. Panofsky and M. Phillips
6. Electromagnetism and Classified Theory, A. D. Barut, Dover
7. Electromagnetic theory and Electrodynamics, by Satya Prakash, Kedar Nath and Co. Meerut.
8. Electromagnetics by B. B. Laud, Willey Eastern.
9. Electrodynamics by Kumar Gupta and Singh.

M.Sc-I, SEM- II, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSE-2A: CLASSICAL MECHANICS

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course Objectives:

- To focus on understanding of the motion and equation of motion of macroscopic bodies.
- To learn to use the functional mathematical notations that's allows precise understanding of fundamental properties of classical mechanics.
- To study the demerits and to overcome them for further development in classical mechanics.

Learning Outcomes:

- Provides the difference between the equation of motion of the one body and many bodies systems as well as the basic formulations such Lagrangian and Hamilton, canonical transformation etc.
- Students can understand how to apply these formulations to the systems to obtain their equation of motions.
- Further, the problems solved during the course will be helpful for SET/NET.

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.

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, SEM- II, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

DSE-2B: CONVENTIONAL AND NON-CONVENTIONAL ENERGY

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

Course Objectives:

To provide a survey of the most important renewable energy resources and the technologies for harnessing these resources within the framework of a broad range of simple to state- of -the-art energy systems.

Learning Outcomes:

Students will be able to

- Demonstrate the generation of electricity from various Non-Conventional sources of energy, have a working knowledge on types of fuel cells.
- Estimate the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
- Explore the concepts involved in wind energy conversion system by studying its components, types and performance.
- Illustrate ocean energy and explain the operational methods of their utilization.

Unit I: Energy Science and Energy Technology

A brief history of energy technology, Various sciences and energy science, Energy, man and environment, Thermodynamics and energy analysis, Classification of conventional and non-conventional energy sources, Global energy trends,

Hydro energy-merits and demerits, Primary hydro energy resources, Types of hydroelectric plants, Energy and power equations, Hydraulic turbines,

Fossil Fuels, Conversion and applications, Types of coal, properties of coal, Coal production and processing.

Unit II: Solar Energy

The solar spectrum, Semiconductors, p-n junction, Solar photocells, Efficiency of solar cells, Commercial solar cells, Developing technologies, Solar panels, Economics of photovoltaics (PV), Environmental impact of photovoltaics, Outlook for photovoltaics,

Solar thermal power plants, Solar thermal collectors, Flat plate collectors, Parabolic collectors, paraboloidal dish collector.

Unit III: Wind and Biomass Energy

Source of wind energy, Global wind patterns, Modern wind turbines, Kinetic energy of wind, Principles of a horizontal-axis wind turbine, Wind turbine blade design, Dependence of the power coefficient C_p on the tip-speed ratio λ, Design of a modern horizontal-axis wind turbine, Turbine control and operation, Wind characteristics, Power output of a wind turbine, Wind farms, Environmental impact and public acceptance, Economics of wind power, Outlook, Conclusion,

Photosynthesis and crop yields, Biomass potential and use, Biomass energy production, Environmental impact of biomass, Economics and potential of biomass, Outlook, Biogas plants, Types of Biogas plants

Unit IV: Nuclear Energy

Binding energy and stability of nuclei, Fission, Thermal reactors, Thermal reactor designs, Fast reactors, Present-day nuclear reactors, Safety of nuclear power, Economics of nuclear power, Environmental impact of nuclear power, Public opinion on nuclear power, Outlook for nuclear power, Magnetic confinement, D-T fusion reactor, Performance of tokamaks, Plasmas, Charged particle motion in E and B fields, Tokamaks, Plasma confinement, Divertor tokamaks, Outlook for controlled fusion.

Reference Books:

1. Energy Technology: Nonconventional, Renewable & Conventional by S. Rao and B.B. Parulekar (3rd Edition, Khanna Publishers).
2. ENERGY SCIENCE: principles, technologies, and impacts, John Andrews and Nick Jelley, Oxford University Press.

M.Sc-I, SEM- II, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

On Job Training/ Field Project

As per NEP 2020

(w. e. f. June 2023-2024)

4 Credits, Marks 100 (80 UA + 20 CA)

(Arrange on job training/Field project at Instrumentation Centre of PAHSUS and CFC , School of Physical Sciences (4 credits) for all the students of University Department and affiliated colleges running M. Sc. Physics)

M. Sc.- I, SEM- II, PHYSICS

(Applied Electronics/ Materials Science/ Energy Studies/ Solid State Physics/ Nanophysics)

Practicals

As per NEP 2020

(w. e. f. June 2023-2024)

Practical 4,5,6.

1) Transistor Parameters.
2) Op-Amp inverting and non-inverting amplifiers.
3) Monostable multivibrator using IC555.
4) FET Characteristics
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.

13) Determination Band gap of Ge Diode.
14) Crystal Structure FCC type.
15) Temp. Variation of Breakdown voltage of Zener diode.
16) Temperature Transducer (Thermistor).
17) P.N. Junction capacitance.
18) LVDT.
19) Photovoltaic cell.
20) Hall Effect.
21) Microcontroller – I- Addition, Subtractor, Multiplication using 89C51 microcontroller.

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