**ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI**
**PG PHYSICS**
**COURSE ATTAINMENT**

| **Blueprint of the question paper** | **Section** | **Unit I** | **Unit II** | **Unit III** | **Unit IV** | **Unit V** |
|---|---|---|---|---|---|---|
| | Section A | 2 | 2 | 2 | 2 | 2 |
| | Section B Any FIVE | 2 | 2 | 1 | 1 | 1 |
| | Section C Either OR | 2 | 2 | 2 | 2 | 2 |
| | Section D Any THREE | 1 | 1 | 1 | 1 | 1 |

**Programme Outcomes**

| **PO No.** | **After completion of the Postgraduate programme, the students of St. Mary's College will be able to** |
|---|---|
| PO 1 | acquire expertise knowledge in their respective disciplinesand become professionals. |
| PO 2 | pursue research / higher learning programmes. |
| PO 3 | compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies. |
| PO 4 | develop critical / logical thinking skills and managerial skills and become locally, nationally & globally competent. |
| PO 5 | apply their experiment and research skills to analyse and solve complex problems. |
| PO 6 | develop themselves as a holistic person assisting in the Nation building process. |
| PO 7 | be a lifelong learner and amenable to new ideas, actively seek out new ways of learning or understanding the world. |
| PO 8 | be an empowered and economically independent woman with efficient leadership qualities in an egalitarian society through liberative education. |

## Program Specific Outcomes:

| PSO No | Students of M.Sc., Physics will be able to | PO Mapped |
|---|---|---|
| PSO 1 | demonstrate and understand the principles and theories of physics. These includes the following classical mechanics, Electromagnetic theory, Electronics and experimental methods, microprocessor and microcontroller, Quantum mechanics, thermodynamics and statistical mechanics, Nuclear and particle physics, Atomic and molecular spectroscopy, Nanoscience and technology and condensed matter Physics | 1 |
| PSO 2 | apply algebra, calculus, tensors and complex variables to solve physics problems. | 4 |
| PSO 3 | demonstrate the ability to do the lab experiments and apply the principles learnt in class | 3 |
| PSO 4 | undertake a major, individual project and report their results in a full scientific report oral or poster presentation. Critically asses a project to evaluate the best strategy to achieve the desired outcome. | 2 |
| PSO 5 | extend and understand the impact of physics and science on society | 5 |
| PSO 6 | demonstrate written and oral communicating physics related topics | 5 |
| PSO 7 | a research-oriented learning that develops analytical and integrative problem-solving approaches. | 6 |
| PSO 8 | help to communicate effectively on energy aspects with the society at large. | 8 |

**ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI**
**Master of Science (Physics)**
**Course Structure (w. e. f 2021)**

**Semester – I**

| Subject | Course code | Course Title | Contact Hours/ Week | Credits | Max.Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| Core I | 21PPHC11 | Classical Mechanics | 6 | 5 | 40 | 60 | 100 |
| Core II | 21PPHC12 | Mathematical Physics I | 6 | 5 | 40 | 60 | 100 |
| Core III | 21PPHC13 | Electronics and Experimental methods | 6 | 5 | 40 | 60 | 100 |
| Elective I | 21PPHE11/ 21PPHE12 | A. Crystal growth &Thin films<br>B. Research Methodology | 6 | 4 | 40 | 60 | 100 |
| Core Practical I | 21PPHCR1 | Electronics | 3 | | | | |
| Core Practical II | 21PPHCR2 | General Physics | 3 | | | | |
| MOOC (Compulsory) | | | | +2 (Extra) | | | |
| | | | **30** | **19** | **160** | **240** | **400** |

**Semester – II**

| Subject | Course code | Course Title | Contact Hours/ Week | Credits | Max.Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| Core IV | 21PPHC21 | Mathematical Physics II | 6 | 5 | 40 | 60 | 100 |
| Core V | 21PPHC22 | Electromagnetic Theory | 6 | 5 | 40 | 60 | 100 |
| Core VI | 21PPHC23 | Thermodynamics and Statistical Mechanics | 6 | 5 | 40 | 60 | 100 |
| Elective II | 21PPHE21/ 21PPHE22 | A. Bio medical Instrumentation<br>B. Microprocessor and Microcontroller | 6 | 4 | 40 | 60 | 100 |
| Core Practical I | 21PPHCR1 | Electronics | 3 | 3 | 40 | 60 | 100 |
| Core Practical II | 21PPHCR2 | General Physics | 3 | 3 | 40 | 60 | 100 |
| | | | **30** | **25** | **240** | **360** | **600** |

**Semester – III**

| Subject | Course code | Course Title | Contact Hours/ Week | Credits | Max.Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| Core VII | 21PPHC31 | Quantum Mechanics – I | 6 | 5 | 40 | 60 | 100 |
| Core VIII | 21PPHC32 | Atomic and Molecular Spectroscopy | 6 | 5 | 40 | 60 | 100 |
| Core IX | 21PPHC33 | Solid State Physics- I | 6 | 5 | 40 | 60 | 100 |
| Elective III | 21PPHE31/21PPHE32 | A. Nano science and Technology<br>B. Energy sources | 6 | 4 | 40 | 60 | 100 |
| Core Practical III | 21PPHCR3 | Microprocessor and Microcontroller& C++ | 3 | | | | |
| Core Practical IV | 21PPHCR4 | Advanced Electronics | 3 | | | | |
| Self Study Course/ MOOC/ Internship (optional) | 21PPHSS1/21PPHM2/21PPHI1 | Physics for Lectureship | - | +2 (Extra) | | 100 | 100 |
| | | | **30** | **19+2** | **240** | **360** | **500** |

**Semester – IV**

| Subject | Course code | Course Title | Contact Hours/ Week | Credits | Max.Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| Core X | 21PPHC41 | Quantum Mechanics – II | 6 | 5 | 40 | 60 | 100 |
| Core XI | 21PPHC42 | Solid State Physics- II | 6 | 5 | 40 | 60 | 100 |
| Core XII | 21PPHC43 | Nuclear and Particle Physics | 6 | 5 | 40 | 60 | 100 |
| Core Project | 21PPHP41 | Project | 6 | 6 | 40 | 60 | 100 |
| Core Practical III | 21PPHCR3 | Microprocessor and Microcontroller& C++ | 3 | 3 | 40 | 60 | 100 |
| Core Practical IV | 21PPHCR4 | Advanced Electronics | 3 | 3 | 40 | 60 | 100 |
| | | | **30** | **27** | **200** | **300** | **500** |

| SEMESTER - I | | | |
|---|---|---|---|
| **Core - I CLASSICAL MECHANICS** | | | |
| **Code : 21PPHC11** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Objectives:**

- Enable the students to understand the basic principles of classical mechanics
- Enhance their problem solving skill towards real life classical system

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | recall basic concepts related to continuous mechanical system. | 1 | Re |
| CO 2 | classify the motion of bodies under the influence of the system of force. | 5 | Ev |
| CO 3 | understand the method of separation of variables | 2 | Un |
| CO 4 | examine the motion of rigid bodies, molecules, planets, satellites and ships by studying Euler's angles. | 3 | An |
| CO 5 | interpret extremely accurate results when studying large objects and speeds approaching the speed of light. | 3 | Ap |
| CO 6 | solve the problems using their knowledge and skills in classical mechanics. | 2 | Ap |

| SEMESTER - I | | | |
|---|---|---|---|
| Core - I CLASSICAL MECHANICS | | | |
| **Code : 21PPHC11** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Unit I: Fundamental Principles and Lagrangian Formulation**

Mechanics of a particle and system of particles –conservation laws- constraints –Principle of virtual work- Generalized coordinates - D' Alembert's principle – Lagrange's equation from D'Alembert'sprinciple –applications of Lagrange's equation (simple pendulum, Atwood machine, compound pendulum) – Hamilton's principle & Lagrange's equation from Hamilton's principle.

**Unit II: Two Body Central Force Problems**

Equivalent one body problems - general features of central force motion-Equivalent one dimensional problem: general features of the orbits-stability of orbits and conditions for closure- Motion under inverse square force: Kepler's problems -Virial theorem -Unbound motion: Rutherford scattering - Centre of mass and laboratory co-ordinates.

**Unit III: Hamilton's Formulation**

Hamilton's equation from variational principle- principle of least action – Canonical Transformation-Legendre transformation- Lagrange and Poisson's brackets – Angular momentum and Poisson bracket Invariance of Poisson's brackets with respect to canonical transformations-Hamilton–Jacobi Equation-Harmonic Oscillator Problem-Hamilton's characteristic function- Action angle variable - Problem of Harmonic oscillator using action-angle variable.

**Unit IV: Rigid Body Problems**

Generalized coordinates of a rigid body- Body and space reference systems-Euler's angles – Angular momentum and inertia tensor-Principle moments of inertia - Moments of Inertia for different body systems - Euler's equations of motion –Torque-free motion of a rigid body-Force free motion of a symmetrical top.

**Unit V: Relativistic Mechanics**

Postulates of Special theory of Relativity – Lorentz transformations – consequences of Lorentz transformations-Relativistic energy-Relation between momentum and energy- Particles with

zero rest mass - The Lagrangian and Hamiltonian formulation of relativistic Mechanics– Covariant formulation of Lagrangian and Hamiltonian.

**Text Books:**

1. Dr.Gupta S L,Kumar V andSharma H V.*Classical Mechanics. Meerut:* Pragati Prakashan. 30th edition2018.

2. Dr.Upadhyaya J C. *Classical Mechanics.*Mumbai: Himalaya Publishing House 3rdEdition 2019.

**Books for Reference:**

1. Gupta B D Satya Prakash.*Classical Mechanics*. 9th revised and Enlarged Edition. 1991.
2. Goldstein Poole and Safko.*Classical Mechanics.*Chennai: Person Education. 3rd Edition 2002.

**21PPHC11 – Classical Mechanics**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | **1.9** | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | **1.9** |
| **CO-2** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | **2.4** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | **2.2** |
| **CO-3** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | **2.5** | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | **2.3** |
| **CO-4** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | **2.6** | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | **2.4** |
| **CO-5** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | **2.6** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | **2.8** |
| **CO-6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | **2.9** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | **2.9** |
| **Average** | **3** | **2.7** | **2.3** | **2.8** | **2.8** | **2.3** | **2.7** | **1.2** | | **3** | **2.8** | **2.2** | **2.3** | **2.3** | **2.3** | **2.7** | **1.3** | |
| PO Mean | | | | | | | | | **2.5** | PSO Mean | | | | | | | | **2.4** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | Medium | | | | |

| SEMESTER - I | | | |
|---|---|---|---|
| **CORE - II MATHEMATICAL PHYSICS – I** | | | |
| **Code : 21PPHC12** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Objectives:**

- Enable the students to solve simple mathematics and make them understand the physical significance behind them
- Enable the students to understand the concepts and applications of mathematical theories.

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | evaluate the area of irregular shape by Green's theorem. | 2 | Ev |
| CO 2 | recall the basic and the special types of matrices. | 1 | Re |
| CO 3 | understand the concepts of feedback control systems with finite dimensional vector spaces. | 7 | Un |
| CO 4 | apply special functions for Wireless communication and alternating current transmission. | 2 | Ap |
| CO 5 | explain the characteristic equation of a matrix using Cayley Hamilton Theorem. | 3 | Ev |
| CO 6 | apply group theory to various disciplines of Physics. | 3 | Ap |

| SEMESTER - I | | | |
|---|---|---|---|
| CORE - II MATHEMATICAL PHYSICS – I | | | |
| **Code : 21PPHC12** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Unit I: Differentiation & Integration of vectors**

Concepts of scalar & vector point functions –gradient of a scalar function – geometrical meaning of gradient – divergence of a vector function – curl – line integral – surface integral – volume integral – Green's Theorem – Stoke's Theorem – Gauss theorem of divergence.

**Unit II: Linear Algebra**

Matrices: Review – Special types – Transpose – Conjugate – Conjugate Transpose – Symmetric and AntiSymmetric– Hermitian and Skew-Hermitian – Determinant – Singular and Non-Singular – Adjoint – Inverse – Orthogonal – Unitary – Trace – Rank - Cramer's rule – Eigen values, Eigen-vectors: Characteristic equation of a Matrix – Cayley-Hamilton theorem.

**Unit III: Special Functions I and Partial Differential Equations**

Legendre Function: Legendre's Equation – Generating Function – Rodrigue's Formula – Orthogonality – Recurrence Formulae – Bessel Function: Bessel's Function of the First kind – Generating Function – Recurrence Formulae.

Introduction – Laplace equation (Cartesian – 3D only) – Heat flow equation (3D only) – Equation motion for the vibrating string (D'Alembert's solution only).

**Unit IV: Complex Analysis**

Complex variables– Limits and continuity – Differentiability –Analytic function- Cauchy-Riemann equations(necessary and sufficient condition, polar form)– Cauchy theorem – Cauchy integral formula – Taylor's theorem – Laurent theorem – Singular points – Residues – Method of finding residues- Residue theorem – Evaluation of definite integrals(unit circle type & evaluation $\int_{-\infty}^{+\infty} \frac{f_1(x)}{f_2(x)}\, dx$ only).

**Unit V: Group Theory**

Group, subgroup, classes – invariant, subgroups, factor groups –homomorphism and isomorphism – grouprepresentation – reducible and irreducible representation – Schur's lemmas, great orthogonality theorem – character table.

**Text Books:**


1. Satya Prakash.*Mathamatical Physics.*New Delhi:Sultan Chand & Sons. 6th edition 2019.
2. Dass H K.*Mathematical Physics.* New Delhi:S.Chand& Company LTD. 8thEdition2018.
3. Chattopadhyay P K.*Mathematical Physics.*New Delhi: New Age International Publishers.2nd Edition 2013.


**Books for reference:**


1. Erwin Kreyszig, *Advanced Engineering Mathematics.* Asia: John Wiley and sons.8th Edition2005.
2. Gupta B D.*Mathematical Physics.* Vikas Publishing house PVT LTD.4thEdition2010.


**21PPHC12 - MATHEMATICAL PHYSICS – I**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2.6 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.3 |
| **CO-2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.6 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.1 |
| **CO-3** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.3 |
| **CO-4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2.6 |
| **CO-5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2.6 |
| **CO-6** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 3 | 3 | 2.2 | 2 | 2 | 2 | | 3 | 3 | 3 | 3 | 2.2 | 2.2 | 2 | 2.2 | |
| PO Mean | | | | | | | | | **2.5** | PSO Mean | | | | | | | | **2.5** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - I | | | |
|---|---|---|---|
| **CORE - III** | **ELECTRONICS AND EXPERIMENTAL METHODS** | | |
| **Code : 21PPHC13** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Objectives:**

- Enable the students to realize the principle of digital electronics and its applications
- Encourage the students to draw their own circuits and therefore make them to understand the concept

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | discuss the working principle of Tunnel Diode, photodiode, LED, LCD, photo conductor and Gunn diode | 1 | Un |
| CO 2 | define Hall Effect | 3 | Re |
| CO 3 | distinguish between the different types of registers | 1 | An |
| CO 4 | analyze the working of D/A and A/D converters | 5 | An |
| CO 5 | classify the working mechanism of different types of transducers | 8 | Ev |
| CO 6 | differentiate between intrinsic and extrinsic semiconductors | 7 | An |

| SEMESTER - I | | | |
|---|---|---|---|
| **CORE - III** | **ELECTRONICS AND EXPERIMENTAL METHODS** | | |
| **Code : 21PPHC13** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**UnitI: Semiconductor Physics**

Energy band theory of semiconductor-Definition of intrinsic and extrinsic semiconductors – Fermi level in intrinsic & extrinsic semiconductor-Diode: tunnel diode-photodiode-LED-LCD –photo conductor-Gunn diode-Hall effect

**UnitII: OP-AMP Applications**

Introduction-the practical op-amp –Input modes and parameters-op-amp audio amplifier- -Waveform generators: Sine and pulse wave generator-triangular wave generator –Schmitt trigger

**Unit III:Registers and Counters**

Types of registers – Serial in-Serial out – Serial in-Parallel out – Parallel in-Serial out – Parallel in-Parallel out – Universal Shift registers Asynchronous counters – Synchronous counters – Changing the counter modulus – Decade counters.

**UnitIV:D/A and A/Dconversion**

Variable-resistornetworks – resistive divider-Binaryladders – D/Aconverters – D/Aaccuracyandresolution – A/Dconverter – Simultaneousconversion – Countermethod – continuousA/Dconversion – A/Dtechniques – A/Daccuracyandresolution.

**UnitV:Transducers**

Transducer-electric transducers –classification of transducers – Summary of factors influencing the choice of Transducers–Resistive transducers: StrainGauges- Theory of strain gauges – Capacitive transducers – Transducers using change in area of plates – Transducers using change in distance between plates –Variation of dielectric constant for measurement of displacement –advantages of capacitive transducers –Piezo electric transducers

**Text Books:**

1. Kakani S K, Bhandari K C,*Electronics Theory and Applications.* New Delhi: New Age International Publishers. Reprint. 2014
2. Thomas L. Floyd.*Electronic Devices conventional current version.* Pearson India Education ServicesPvt.Ltd. 9th Edition2020.
3. Jacob Milman and Christos C.Halkias.*Integrated Electronics.* India: Tata Mc Graw Hill. 2nd

Edition1991.

4. DonaldP.Leach,Albert Paul Malvino and Goutam Saha. *Digital Principles and Applications.*New Delhi: The Mc GRAW-Hill Publishing Company Ltd. 6th edition 2008.

5. Sawhney A K. *ElectricalandElectronicMeasurementsandInstrumentatin.* Delhi: DhanpatRaiSons,EducationalandTechnicalPublishers.4th edition.

**Book for reference:**

1. Ramakanth A. Gayakwad. *Op-Amp and Linear Integrated Circuit.* New Delhi: Prentice Hall of India Pvt. Ltd.1988.

**21PPHC13 - ELECTRONICS AND EXPERIMENTAL METHODS**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.25 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.125 |
| **CO-2** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2.25 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2.125 |
| **CO-3** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.25 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.125 |
| **CO-4** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2.5 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2.125 |
| **CO-5** | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2.5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2.125 |
| **CO-6** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2.625 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2.125 |
| **Average** | 3.0 | 2.67 | 2.67 | 2.0 | 2.5 | 2.17 | 2.0 | 2.17 | | 2.33 | 2.0 | 2.17 | 2.0 | 2.17 | 2.0 | 2.17 | 2.17 | |
| PO Mean | | | | | | | | | 2.4 | PSO Mean | | | | | | | | **2.1225** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | Strong | | | | |

| SEMESTER - I | | | |
|---|---|---|---|
| **ELECTIVE – I A. CRYSTAL GROWTH & THIN FILMS** | | | |
| **Code :21PPHE11** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Objectives:**

- Make the students to know the crystal growth and thin film techniques and to know their characterization techniques
- Make the students to choose their own project independently

**Course Outcome:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | generate an understanding of self-assembly during the process of growth | 1 | Un |
| CO 2 | apply the processskills of scientificinquiry duringexperimentation | 4 | Ap |
| CO 3 | classify the arrangement of SEM, TEM | 4 | Ev |
| CO 4 | apply the techniques of SEM and TEM to their own research projects | 5 | Ap |
| CO 5 | distinguish the differences and similarities between different deposition techniques. | 1 | An |
| CO 6 | recognize appropriate material for the fabrication of a device | 4 | Re |

| SEMESTER - I | | | |
|---|---|---|---|
| **ELECTIVE - I** | **A.CRYSTAL GROWTH & THIN FILMS** | | |
| **Code :21PPHE11** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Unit I: Introduction**

Crystal growth – significance of Single crystals - crystal growth techniques- chemical physics of crystal growth. Nucleation – Theories of nucleation - classical theory of nucleation – Heterogeneousnucleation-Kinetics of crystal growth.

**Unit II: Growth Techniques**

Solution growth: Low temperature solution growth – crystal growth system – High temperaturesolution growth. Gel growth: various types of gel – Experimental procedure– Biological crystallization.

**Unit III: Characterization Technique**

Diffraction analysis – X-ray diffraction- electron & neutron diffraction - TEM, instrumental details - SEM – AFMThermal analysis-thermo gravimetric analysis-differential thermal analysis-differential scanning calorimeter- Microhardness (Nano hardness) – Classification of hardness test –Vickers hardness test – Knoop hardness test.

**Unit IV: Thin film**

Preparation of thin films: thermal evaporation- flash evaporation -electron gun beam method –cathodic sputtering- chemical vapour deposition. Thickness measurements – ellipsometry – interferometry.

**Unit V: Technological application of thin film**

Thermistor-varistor-strain gauge element-capacitor - active devices-microelectronics, IC and other applications-Discrete resistive components: resistors-carbon films-oxide and nitride films- cermet films-metal films.

**Text Books:**


1. Dr. SanthanaRagavan P andRamasamy P.*Crystal growth processes andmethods*. Kru Publications. 2000.
2. Rajendran V.*Material Science.* NewDelhi: Mcgraw hill.1st reprint 2012.
3. Goswami A.*Thin film fundamental.*New Delhi: New age international (P) Ltd.1stEdition 1996.

**Books for Reference:**


1. Brice J C.*Crystal growth processes.*London: Blackie & Son Ltd.1986.
2. Pamplin B R. *Crystal growth.*2nd Edition 1980.
3. Hurle D T J,*Crystal pulling from melt.* 1990.
4. Raghavan V.*Material science & Engineering – A first course.*5th Edition 1974.


**21PPHE11 - CRYSTAL GROWTH & THIN FILMS**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2.25 |
| **CO-4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | |
| PO Mean | | | | | | | | | **3** | PSO Mean | | | | | | | | **2.875** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - I | | | |
|---|---|---|---|
| **ELECTIVE -I** | **B. RESEARCH METHODOLOGY** | | |
| **Code : 21PPHE12** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Objectives:**

- Enable the students to understand research problem and research design
- Enable the students to understand the steps behind research paper writing

**Course Outcomes:**

| **CO No.** | **Upon completion of this course, students will be able to** | **PSOs addressed** | **CL** |
|---|---|---|---|
| CO 1 | list the types of research depending on the approaches | 1 | Re |
| CO 2 | explain the criteria of a good research | 6 | Un |
| CO 3 | examine the selection process of the problem based on necessity. | 4 | An |
| CO 4 | apply secondary data methods of collecting primary data | 6 | Ap |
| CO 5 | grade the formulation of the selected problem | 4 | Ev |
| CO 6 | identify the meaning of interpretation techniques | 4 | An |

| SEMESTER - I | | | |
|---|---|---|---|
| **ELECTIVE -I (B) RESEARCH METHODOLOGY** | | | |
| **Code : 21PPHE12** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Unit I: An Introduction to Research Methodology**

Meaning of research-Objectives-Types of research- Research Approaches-Significance-Research methods versus methodology- Research and scientific method- Importance of knowing how research is done- Research process- Criteria of good research- Problems encountered by researchers in India.

**Unit II: Defining the Research Problem and Research design**

Research problem- Selecting the problem- Necessity of defining a problem-Technique involved in defining a problem- Meaning of research design- Need- Features of good Design-Important Concepts-Basic principles of experimental designs.

**Unit III: Plagiarism**

Plagiarism - Forms of plagiarism - Unintentional plagiarism - Examples of plagiarism - Consequences - How to avoid plagiarism - Being aware of and identifying different types of plagiarism - Things you can do to avoid plagiarism - Types of plagiarism - Online plagiarism - Web of science - h-index - Scopus.

**Unit IV: Review of literature**

Need for reviewing literature- What to review and for what purpose - Literature search procedure- Sources of literature- Planning the review work – Note taking – The planning process- Selection of a problem for research- Formulation of selected problem.

**Unit V: Interpretation and report writing**

Meaning of interpretation- Technique- Precaution- Significance- Different steps- Layout of research reports - Types of reports- Oral presentation- Mechanics of writing a research report-Precautions for writing a research report.

**Text Books:**


1. Kothari C R and Gaurav Garg. *Research methodology methods and techniques.* Delhi: New age international. 3rdEdition 2014.
2. Krishna swamy O R, Ranganatham M. *Methodology of research in social studies.* Mumbai*:* Himalaya Publishing House.2nd Edition 2011.
3. https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism (Plagiarism)
4. https://www.scanmyessay.com/plagiarism/consequences-of-plagiarism.php

5. https://www.scanmyessay.com/plagiarism/types-of-plagiarism.php (Types of plagiarism)
6. https://www.scanmyessay.com/plagiarism/how-to-avoid-plagiarism.php (How to avoid plagiarism)
7. https://www.scanmyessay.com/plagiarism/online-factors.php (Online plagiarism)
8. https://en.m.wikipedia.org/wiki/Web_of_Science (Web of science)
9. https://en.m.wikipedia.org/wiki/H-index (h-index)
10. https://en.m.wikipedia.org/wiki/Scopus (Scopus)

**Books for Reference:**


1. Gupta S P.*Statistical methods. New Delhi:* Sultan Chand & Sons. 40th Edition. 2011.
2. Saravanavel P.*Research Methodology.* Jaipur: Kitab Mahal. Reprint, 16th Edition 2010.


**21PPHE12 - RESEARCH METHODOLOGY**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | Avg | PSO-1 | PSO-2 | PSO-3 | PSO-4 | PSO-5 | PSO-6 | PSO-7 | PSO-8 | Avg |
| **CO-1** | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | **2.2** | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | **2.1** |
| **CO-2** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | **2.3** | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | **2.4** |
| **CO-3** | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | **2.5** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | **2.3** |
| **CO-4** | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | **2.4** | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | **2.4** |
| **CO-5** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | **2.6** | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | **2.5** |
| **CO-6** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | **2.3** | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | **2.6** |
| **Average** | **2.7** | **2.3** | **2.2** | **2.2** | **2.5** | **2** | **2.8** | **2.2** | | **2.7** | **2** | **2.2** | **2.3** | **2.3** | **2.3** | **3** | **2.2** | |
| PO Mean | | | | | | | | | **2.4** | PSO Mean | | | | | | | | **2.4** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | | Medium | | | |

| SEMESTER - II | | | |
|---|---|---|---|
| **CORE IV** | **MATHEMATICAL PHYSICS II** | | |
| **Code : 21PPHC21** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Objectives:**

- Enhance the ability of the students by providing higher level mathematics such as tensor, special functions, transformations etc
- Enable the students to understand the principle behind the concepts and their real life application

**Course Outcome:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | analyse the experimental data with the aid of Fourier transform | 4 | An |
| CO 2 | recall the basic notations of generating functions and special functions | 1 | Re |
| CO 3 | apply computational techniques to solve a wide range of numerical problems arising in physics | 2 | Ap |
| CO 4 | explain the concepts of Laplace Integral | 1 | Un |
| CO 5 | employ the knowledge of critical thinking and problem solving | 5 | Ap |
| CO 6 | recommend the correct method to solve a particular problem | 2 | Ev |

| SEMESTER - II | | | |
|---|---|---|---|
| CORE IV MATHEMATICAL PHYSICS II | | | |
| **Code : 21PPHC21** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Unit I: Linear differential equations of first & second order**

Order and degree of a differential equation- solution of differential equations of first order & first degree (variables separable, homogeneous equation)- linear differential equations of second order with constant coefficients-method of finding complementary function- rules to find particular integral- problems.

**Unit II: Tensors**

Notations and conventions–contravariant vector-covariant vector- tensors of second rank – equality and null tensor– addition and substraction – outer product of tensors– inner product of tensors– symmetric and antisymmetric tensor– metric tensor– Cartesian tensor– isotropic tensor– stress, strain and Hooke's law-Moment of inertia tensor.

**Unit III: Special Functions II**

**Hermite functions:** Hermite Differential Equation– Hermite Polynomials– Recurrence Formulae– Rodrigue's Formula**Laguerre function:** Differential equation– Laguerre polynomial – Generating Function– Rodrigue's Formula– Recurrence Relation.

**Unit IV: Numerical methods**

Solution of non – linear equation: Newton – Raphson's method – Solution of Linear Algebraic Equations: Gauss elimination, Interpolation: Lagrange's interpolation– Inverse interpolation – Finite differences– Newton's forward and backward interpolation – Numerical Integration: Trapezoidal rule – Simpson's $1/3^{rd}$ and $3/8^{th}$ rule – Runge-Kutta method(Fourth order).

**Unit V: Fourier &Laplace's Integral Transforms**

**Fourier Integral Transforms:** Fourier transform- properties of FT–FT of a derivative-Finite FT**Laplace Integral transform:** properties of Laplace transform-Laplace transforms of derivative of a function– Laplace transform of integral – inverse Laplace transform–properties of inverse Laplace transform- Evaluation of ILT by convolution theorem- Method of partial fractions for evaluation of ILT

**Text Books:**

1. Satya Prakash.*Mathematical Physics*.New Delhi: Sultan Chand &Sons.4th Edition 2004.
2. Joshi A W.*Matrices and tensors in Physics.*Delhi: New Age International Publishers. Reprint, 3rd Edition 2010.
3. Singaravelu A. *Numerical Methods*.Chennai: Meenakshi Agency.2nd Edition 2011.

**Books for Reference:**

1. Chattopadhyay P K.*Mathematical Physics.* Delhi: New Age International Publishers. Reprint 2001.
2. Dass H K. *Mathematical Physics.*New Delhi: S.Chand& Company LTD.4thEdition2004.

**21PPHC21 - MATHEMATICAL PHYSICS II**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | **3** | **3** | **3** | **3** | **2** | **2** | **3** | **2** | **2.6** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2.3** |
| **CO-2** | **3** | **3** | **3** | **3** | **3** | **2** | **2** | **2** | **2.6** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2.3** |
| **CO-3** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2.4** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2.3** |
| **CO-4** | **3** | **3** | **3** | **3** | **2** | **2** | **2** | **2** | **2.5** | **3** | **3** | **3** | **3** | **2** | **2** | **1** | **2** | **2.3** |
| **CO-5** | **3** | **3** | **3** | **3** | **2** | **2** | **2** | **2** | **2.5** | **3** | **3** | **3** | **3** | **2** | **2** | **3** | **2** | **2.6** |
| **CO-6** | **3** | **3** | **3** | **3** | **2** | **2** | **2** | **2** | **2.5** | **3** | **3** | **3** | **3** | **2** | **2** | **3** | **2** | **2.6** |
| **Average** | **3** | **3** | **3** | **3** | **2.2** | **2** | **2** | **2** | | **3** | **3** | **3** | **3** | **2.2** | **2.2** | **2** | **2.2** | |
| PO Mean | | | | | | | | | **2.5** | PSO Mean | | | | | | | | **2.5** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - II | | | |
|---|---|---|---|
| **CORE V** | **ELECTROMAGNETIC THEORY** | | |
| **Code : 21PPHC22** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Objectives:**

- Make the students to understand the basics of electro, magneto statics as well as electrodynamics
- Make them to know the propagation of waves and wave guides

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | recall the fundamental concepts of electromagnetic theory | 1 | Re |
| CO 2 | compare electrostatics with magnetostatics | 1 | Un |
| CO 3 | construct Maxwell's equations and identify each mathematical operator and physical quantity in the equations | 3 | Ap |
| CO 4 | analyze different waves and conduct a mock trial on electromagnetic radiation | 5 | An |
| CO 5 | recommend the types of wave guides used in optical communication | 1 | Ev |
| CO 6 | distinguish transmission lines and waveguides and analyze propagation of signal in different modes | 1 | An |

| SEMESTER - II | | | |
|---|---|---|---|
| **CORE V** | **ELECTROMAGNETIC THEORY** | | |
| **Code : 21PPHC22** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Unit I: Electrostatics**

Coulomb's Law – Electric field– Continuous charge distribution– Gauss Law – Poisson's Equation and – Laplace's Equation – Work Done to move a point charge – Energy of a point charge and continuous charge distribution – Gauss Law in the presence of dielectric – Susceptibility, Permittivity and Dielectric constant of linear dielectrics.

**Unit II: Magnetostatics**

Biot-Savart's – Steady current – Magnetic field of a steady current – Ampere's Law – Comparison of Magnetostatics and Electrostatics – Magnetic vector potential – Multipole expansion of the vector potential – Effects of a Magnetic field on atomic orbits –Ampere's law in Magnetized Materials.

**Unit III: Electrodynamics**

Maxwell Equation (Both Differential and Integral Formulations) –Scalar and Vector Potentials – Gauge transformations – Lorentz and Coulomb Gauges –Continuity Equation – Poynting Vector and Poynting's Theorem – Maxwell's Stress Tensor.

**Unit IV: Electromagnetic Waves and Radiations**

The Wave Equation for E and B – Monochromatic plane waves– Magnetic Charge – Propagation of EM Waves in Linear media – Reflection and transmission at normal and oblique incidence– Radiation – Electric dipoleradiation –Magnetic dipole radiation.

**Unit V: Wave Guides**

Wave guides TM mode, TE mode and TEM mode – Rectangular wave guide TE – Rectangular wave guide TM mode – Circular wave guide – resonant cavities.

**Text Books:**

1. David J.Griffiths. *Introduction to Electrodynamics.*Chennai: Prentice hall of India.2nd Edition1989.
2. Satya Prakash. *Mathamatical Physics.*New Delhi: Sultan Chand & Sons.6th Edition 2019.

**Books for Reference:**

1. Paul Lorraius and Dale Corson. *Electromagnetic Fields and Wave.* CBS Publishers & distributors. 2nd Edition2003.

**21PPHC22 - ELECTROMAGNETIC THEORY**

| | **PO** | | | | | | | | | **PSO** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2.375 |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 2.25 |
| **CO-4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 2.8 | 2.6 | 3 | 2.6 | 3 | 2.6 | 2.6 | 2.6 | |
| PO Mean | | | | | | | | | **3** | PSO Mean | | | | | | | | **2.77** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | Strong | | | | |

| SEMESTER - II | | | |
|---|---|---|---|
| **CORE VI THERMODYNAMICS AND STATISTICAL MECHANICS** | | | |
| **Code : 21PPHC23** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Objectives:**

- Enable the students to understand different ensembles
- Make them to understand different microscopic system

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | understand working knowledge of the zeroth, first, second and third law of thermodynamics | 1 | Un |
| CO 2 | apply statistics in different systems containing atoms and molecules | 2 | Ap |
| CO 3 | inspect the partition function for the microcanonical, canonical, grand canonical ensemble | 1 | An |
| CO 4 | recall the loss of thermodynamics and equipartition theorem from the statistical description using microstates | 1 | Re |
| CO 5 | assess about phase transitions and black body radiation | 5 | Ev |
| CO 6 | apply energy changes in chemical reaction using the first law of thermodynamics | 2 | Ap |

| SEMESTER - II | | | |
|---|---|---|---|
| **CORE VI THERMODYNAMICS AND STATISTICAL MECHANICS** | | | |
| **Code : 21PPHC23** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Unit I: Thermodynamics**

Thermodynamics –System and its surroundings- Zeroth, First, Second and Third law of thermodynamics-applications-Reversible and irreversible process-heat engines-Kelvin Planck statement of the second law – Entropy –change of entropy in a reversible & irreversible process-Joule Thompson expansion– Maxwell's thermodynamic relations – Thermodynamic potentials – Chemical potential and Gibbs Duhem equation

**Unit II : Thermodynamics of Magnetism**

Chemical potential – phase equilibrium and the phase rule-dependence of vapour pressure on total pressure-surface tension- vapour pressure of a liquid drop – The Reversible voltaic cell-black body radiation- Thermodynamics of magnetism.

**Unit III: Basis of Statistical Mechanics**

Phase space – Ensemble – Liouville theorem – Conservation of extension in phase – Equation of motion – Equal a priori probability – Statistical Equilibrium – Micro canonical Ensemble – Quantisation of Phase space – Symmetry of wave functions – Effect of symmetry of counting – Various distributions using micro canonical ensemble.

**Unit IV: Ensemble & Statistical Thermodynamics**

Gibbs paradox – Sackur- Tetrode equation – Entropy of a system in contact with a heat reservoir- Ideal gas in canonical ensemble – Grand canonical ensemble – Ideal gas in grand canonical ensemble – Comparison of various ensembles – Quantum distributions using other ensembles Macro states and microstates – Bose-Einstein distribution function – Fermi-Dirac distribution function – Maxwell-Bolltzman distribution function – Partition function

**Unit V: Ising model and Fluctuations**

Phase transitions of the second kind – Ising model – Bragg-Williams approximations – Kirkwood method-One dimensional Ising model-Fluctuations in ensembles – concentration fluctuations in quantum statistics – One dimensional random walk – Brownian motion.

**Text Books:**


1. Dass V N.*Heat and thermodynamic.*Delhi: Dominant Publishers.1st Edition 2005.
2. Gupta M C.*Statistical Thermodynamics.* New Delhi: New Age International P Ltd.Reprint 2009.
3. Sears Salinger. *Thermodynamics, Kinetic Theory and Statistical Thermodynamcis.*

New Delhi: Narosa publishing house pvt Ltd.3rdEdition 2017.
4. Agarwal B K, Melvin Eisner.*Statistical Mechanic*.New Delhi: New age international P Ltd. Reprint 2002.

**Books for reference:**

1. Kerson Huang.*Statistical Mechanics.*New York: John Wiley & Sons, Inc. Second edition. 1987.
2. Dasgupta A K.*Fundamentals of Statistical Mechanics. Culcutta:* New Central Book Agency (P) Ltd. 2000.
3. Sears and Zymanski. *Statistical Mechanics.*New York: McGraw Hill Book Company.1961.
4. Federick Reif.*Fundamentals of Statistical and thermal Physics,*Singapore: McGraw Hill International Editions.1985.

## 21PPHC23 - THERMODYNAMICS AND STATISTICAL MECHANICS

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | Avg | PSO-1 | PSO-2 | PSO-3 | PSO-4 | PSO-5 | PSO-6 | PSO-7 | PSO-8 | Avg |
| **CO-1** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | **2.25** |
| **CO-2** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | **2.5** | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | **2.25** |
| **CO-3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** |
| **CO-4** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | **2.25** | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | **2.38** |
| **CO-5** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** |
| **CO-6** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | **2.5** | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | **2.25** |
| **Average** | **2.83** | **2.33** | **2.17** | **2.5** | **2.0** | **2.33** | **2.0** | **2.0** | | **2.5** | **2.0** | **2.17** | **2.17** | **2.17** | **2.5** | **2.17** | **2.17** | |
| PO Mean | | | | | | | | | **2.27** | PSO Mean | | | | | | | | **2.23** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - II | | | |
|---|---|---|---|
| **ELECTIVE – II A. BIO-MEDICAL INSTRUMENTATION** | | | |
| **Code :21PPHE21** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Objectives:**

- Give the students basic knowledge about different life saving machines
- Enable the students to understand the principle behind the working of these instruments

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | define resting and action potentials | 1 | Re |
| CO 2 | classify the uses of electrode paste | 1 | Ap |
| CO 3 | discuss the principle of operation of different types of transducers | 8 | Un |
| CO 4 | interpret the output of bio potential recorders such as ECG, EEG and EMG | 5 | Ev |
| CO 5 | investigate internal and external pacemakers | 1 | An |
| CO 6 | illustrate the working of different kinds of radiation monitoring instruments | 3 | Ap |

| SEMESTER - II | | | |
|---|---|---|---|
| **ELECTIVE - IIA. BIO-MEDICAL INSTRUMENTATION** | | | |
| **Code :21PPHE21** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Unit I: Human physiological systems and transducers**

Cells and their structure-resting and action potentials – Design of medical instruments – Components of the Bio-medical instrument system – Electrodes: electrode potential-purpose of electrode paste-electrode material-Types of electrodes – Transducers Types: active – magnetic induction type-piezoelectric-photovoltaic-thermo electric-passive-resistive

**Unit II: Bio-Potential Recorders**

Introductions-characteristics- ECG: origin-lead configuration-practical consideration-analysis–EEG: origin-brain waves –analysis–EMG:recording set up-determination of conduction velocities in motor nerves

**Unit III: Physiological Assist Devices And Operation Theatre Equipments**

Pacemakers: energy requirements to excite heat muscle-methods of stimulation-different modes of operation:Ventricular synchronous pacemaker-Atrial synchronous pacemaker

Kidney Machine: Renal function-dialysis-hemodialysis-peritoneal dialysis – Ventilators – Anesthesia machine

**Unit IV: Safety Instruments**

Radiation Safety Instrumentation-Physiocological Effect due to 50 Hz current passage – Microshock and Macroshock – Electrical accidents in hospitals – Devices to protect against electrical hazards.

**Unit V: Advances In Biomedical Instrumentation**

Computers in medicine – Lasers in medicine – Endoscopes – cryogenic surgery – Nuclear Imaging techniques – Computer Tomography –MRI

**Text Books:**

1. Dr. Arumugam M.*Biomedical Instrumentation.*Chennai: Anuradha publications. 10thEdition 2013.

## 21PPHE21 - BIO-MEDICAL INSTRUMENTATION

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | **1.9** | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | **1.8** |
| **CO-2** | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | **1.9** | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | **1.5** |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | **2.6** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | **2.1** |
| **CO-4** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | **2.6** | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 1 | **2.4** |
| **CO-5** | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | **2.6** | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | **2.4** |
| **CO-6** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | **2.6** | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | **2.5** |
| **Average** | **2.8** | **2.8** | **2.3** | **2.7** | **2.7** | **2** | **2.2** | **1.8** | | **2.8** | **2** | **2.5** | **2** | **1.8** | **1.8** | **2.3** | **1.5** | |
| PO Mean | | | | | | | | | **2.4** | PSO Mean | | | | | | | | **2.1** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | Medium | | | | |

| SEMESTER - II | | | |
|---|---|---|---|
| **ELECTIVE II B. MICROPROCESSOR AND MICROCONTROLLER** | | | |
| **Code :21PPHE22** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 4** |

**Objectives:**

- Enable the students to understand microprocessor and microcontroller
- Enable them to write simple programs
- Enable them to interface microprocessor and microcontroller with other simple devices

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | understand the architectures and instruction sets of microprocessors and microcontrollers | 1 | Un |
| CO 2 | verify bus transactions, memory organisation and address decoding, basic I/O interfaces and port addressing | 1 | Ev |
| CO 3 | apply and implement learned algorithm design techniques and data structures to solve the problems | 2 | Ap |
| CO 4 | understand the interfacing of peripheral devices like I/O ports, keyboards, displays, ADCs, DACs, stepper motor | 1 | Un |
| CO 5 | analyze concepts associated with interfacing a microprocessor to memory and to I/O devices | 6 | An |
| CO 6 | recall a microprocessor programming model at a level that enables to write assemble language programs for the processor meeting given specifications | 6 | Re |

| SEMESTER - II | | | |
|---|---|---|---|
| **ELECTIVE II B.MICROPROCESSOR AND MICROCONTROLLER** | | | |
| **Code :21PPHE22** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 4** |

**Unit I: Microprocessor Architecture and Instruction set**

Intel 8085 Architecture-Instruction format-8085 programming model-instruction classification-8085Instructionset – Data transfer operations –Arithmetic instructions – Logic operations-Branch operations.

**Unit II: Microprocessor Programming &Counters and Time Delays**

Writing assembly language programs-Programming techniques: Looping, Counting and Indexing –Stack-Subroutine--8085 Interrupt-counters and time delays

**Unit III: Microprocessor Interfacing**

Techniques for time delay-Basic interfacing concept-8255(PPI)-Interfacing Keyboard and Seven Segment Display- Microprocessor based stepper motor-waveform generator using ADC and DAC

**Unit IV: Microcontroller Programming**

Addressing mode of microcontroller 8051-arithmetic and logical instruction-8051 assembly language programmes: addition, subtraction, division, multiplication- interfacing 8051 with LED display and keyboard.

**Unit V: Addressing Modes & Delay**

Register Addressing -Direct byte addressing- Register indirect addressing-Immediate addressing-Logical Instructions-Time delay for 8051-Assembling and running an 8051 program

**Text Books:**


1. RameshGaonkar.*Microprocessor ArchitectureProgrammingandApplicationswithThe8085.* India: Penram International PublishingPrivateLimited. Fifth edition. 2011.
2. karuna Sagar D,*Microcontroller,8051.*Delhi: Narosha publishing house PVT Ltd, Print.2011.
3. Dr.Godse A P. *Microprocessor and Microcontroller.*Technical Publications.Fourth Revised edition.2017.

**Books for reference:**

1. Aditya.P.Mathur.*Introduction to Microprocessors.* New Delhi: Tata Mc Graw Hill Education P Ltd. Third Edition.

2. Ram B and Sanjay Kumar. *Fundamental of microprocessors and micro controllers.* New Delhi: Dhanpat rai Publications (P) Ltd. seventh revised Edition.

**21PPHE22 - MICROPROCESSOR AND MICROCONTROLLER**

| | **PO** | | | | | | | | | **PSO** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2.6 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.4 |
| **CO-2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.6 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.4 |
| **CO-3** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2.4 |
| **CO-4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2.6 |
| **CO-5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2.6 |
| **CO-6** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2.6 |
| **Average** | 3 | 3 | 3 | 3 | 2.2 | 2 | 2 | 2 | | 3 | 3 | 3 | 3 | 2.2 | 2.2 | 2 | 2.2 | |
| PO Mean | | | | | | | | | **2.5** | PSO Mean | | | | | | | | **2.6** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | | Strong | | |

| SEMESTER - III | | | |
|---|---|---|---|
| **Core - VII QUANTUM MECHANICS – I** | | | |
| **Code: 21PPHC31** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Objectives:**

- To enable students, understand the fundamentals of Quantum Mechanics and their applications to microscopic systems.

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | recall Schrodinger equation | 1 | Re |
| CO 2 | describe Ehrenfest's theorem and its verification | 1 | Un |
| CO 3 | evaluate the commutation relations between the various quantum mechanical operators | 6 | Ev |
| CO 4 | analyse the linear harmonic oscillator problem using wave formalism and matrix formulation | 2 | An |
| CO 5 | interpret equations of motion in the Schrodinger picture, Heisenberg picture and Interaction picture | 1, 2 | Ap |
| CO 6 | combine spin and angular momenta | 7 | Ap |

| SEMESTER - III | | | |
|---|---|---|---|
| Core - VII QUANTUM MECHANICS – I | | | |
| **Code : 21PPHC31** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Unit I: Fundamentals of wave mechanics**

Wave Particle Duality – De - Broglie waves – Equation of motion of matter waves (Time Independent Schrodinger equation and Time dependent Schrodinger equation) – Physical interpretation - Normalized and orthogonal wave functions – Solution of Schrodinger equation– Expectation values - Probability current density –Ehrenfest Theorem– Uncertainty principle– Applications.

**Unit II: Operators**

Hilberts space - linear vector space -Bra &Ket vectors - properties – Dirac Notation – Operator(linear, Hermitian, projection, unitary, parity) – Representation in discrete bases – Representation in continuous bases - position and momentum representation.

**Unit III: Applications of Schrödinger equation to one, three Dimensional problems**

Particle in a box - Rectangular Potential Barrier – Applications of Barrier penetration – Particle in one dimensional infinitely deep potential well –One dimensional Linear Harmonic Oscillator (Eigen values and Eigen functions)- Harmonic oscillator - Rigid rotator with free axis - Rigid rotator in a fixed plane - Hydrogen atom.

**Unit IV: Matrix Representation and Angular momentum**

Schrodinger, Heisenberg matrix representation - Angular momentum operator - Total angular momentum operators – Commutation relations – Eigen values of $J^2$ ,$J_z$ , $J_+$, J- , $J_x$ and $J_y$ – ClebschGorden coefficients – Calculation of ClebschGorden coefficients $J_1 = 1/2$, $J_2 = 1/2$.

**Unit V: Identical Particle and Spin**

Symmetric and anti – Symmetric wave function – Particle exchange operator – Pauli's Exclusive principle – Spin matrices of electron– Commutation relation – Properties of Pauli operator – Pauli Eigen values and Eigen function – Electron Spin function – Statistical Weight-Density operator and Density matrix – Time dependent of density matrix.

**Text Books:**


1. Schiff L. *Quantum Mechanics.* New Delhi: Tata Mc-Graw Hill Education Private Limited. Second reprint, Fourth Edition 2019.
2. Aruldhas G. *Quantum Mechanics.*Delhi: Prentice Hall of India Learning Private Limited.Twenty First Print,Second edition 2019.
3. Satya Praksh. *Advanced Quantum Mechanics*.Meerut: Kedar Nath Ram Nath Publications. Fifth revised edition 2021.


**Books for Reference:**


1. Mathews P.M and Venkatesan K.*A Text Book of Quantum Mechanics*. NewDelhi: Tata McGraw Hill Publishing Company Limited.16th reprint ,second edition.2007
2. Shankar R.*Principles of Quantum Mechanics.*New York: Plenum Publishers. Second Edition 1994.

3. Sakurai J J.*Modern Quantum Mechanics.* Addison- Wesley Publishing Company. Revised edition 1994.
4. Rajasekar S and Velusamy R. *Quantum Mechanics I: Fundamentals.* London: CRC Press. Taylor and Francis group- Boca Raton. e-book version 2015.

**21PPHC31 - QUANTUM MECHANICS – I**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2.4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2.4 |
| **CO-2** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.6 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.6 |
| **CO-4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **CO-5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **CO-6** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **Average** | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 | | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 | |
| PO Mean | | | | | | | | | **2.5** | PSO Mean | | | | | | | | **2.5** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - III | | | |
|---|---|---|---|
| **CORE – VIII ATOMIC AND MOLECULAR SPECTROSCOPY** | | | |
| **Code:21PPHC32** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Objectives:**

- To enable the students to understand the atomic and molecular spectrum with the ultimate clarity that quantum mechanics allows.
- To enhance the knowledge of origin of atomic spectra, rotational, vibrational, Raman and mossbauer spectroscopy.

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | explain the structure of atoms and the origin of the observed spectra | 1 | Un |
| CO 2 | examine rotational spectra, get information about molecular dimension and atomic masses | 4 | An |
| CO 3 | apply knowledge of Mossbaur spectroscopy in solid state physics and nanotechnology | 4 | Ap |
| CO 4 | assess how nuclear spins are affected by magnetic field and able to explain what happens when radio frequency radiation is observed | 1 | Ev |
| CO 5 | recall the basic hydrogen spectra | 1 | Re |
| CO 6 | explain the key properties of many electron atoms and the importance of the Pauli's exclusion principle | 1 | Ev |

| SEMESTER - III | | | |
|---|---|---|---|
| **CORE – VIII ATOMIC AND MOLECULAR SPECTROSCOPY** | | | |
| **Code:21PPHC32** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Unit I: Spectra of atoms**

Hydrogen Spectrum-Angular momentum-Larmor Precession-Energy of a magnetic moment in a magnetic field-Vector atom model-Spin –orbitinteraction-Spectra of alkali atoms-angular momentum of many electrons atoms-Normal ZeemanEffect-Anomalous Zeeman Effect-Paschen - Back Effect-hyperfine structure-Stark Effect-LambShift-Characteristic X-ray Spectra.

**Unit II: Microwave Spectroscopy**

Microwave Spectroscopy: The rotation of molecules–Rotational spectra–Diatomic molecules–Polyatomic molecules–Techniques and Instrumentation-Microwave spectrometer-Applications.

**Unit III: Infra-Red Spectroscopy**

Infra-Red Spectroscopy: Vibrational energy of a diatomic molecule-The vibrating diatomic molecule – The Diatomic vibrating rotator-The interactions of rotations and vibrations- The vibrations of polyatomic molecules- IRspectrometer-FTIR-Applications.

**Unit IV: Raman Spectroscopy and Mossbauer Spectroscopy**

Theory of Raman spectroscopy-Rotational Raman spectra- vibrational Raman spectra-mutualexclusion principle-Raman spectrometer-structure determination using IR and RamanSpectroscopy-Resonance Raman scattering.

**Mossbauer Spectroscopy:** Principles of Mossbauer-Applications of Mossbauer Spectroscopy

**Unit V: Resonance Spectroscopy**

**NMR:** Magnetic properties of nuclei-Resonance condition-NMR instrumentation-Relaxationprocess-Bloch equation-Chemical shift- NMR imaging

**ESR:** The hyperfine structure – Double resonance – Fine structure - Techniques of ESRspectroscopy.

**Text Books:**


1. Banwell C N. *Fundamentals of Molecular spectroscopy*. New Delhi: Tata McGraw hill Publishing Company.9th reprint,4thEdition 2020.
2. Aruldhas G.*Molecular structure & Spectroscopy.* Prentice Hall Private Ltd. Second edition 2018.


**Books for reference:**


1. Barrow G M.*Introduction to Molecular Spectroscopy.*MGH Publishing Company.17thprint.
2. Gary M.Lampman, Donald L.Pavaia, George S.Keiz, James R.Vyvyan.*Spectroscopy.*Delhi: Cengage Learning India P Ltd. 4th Edition.
3. Dutta M K.*Atomic and Molecular Spectroscopy.*Delhi: IVY Publishing House. 1stEdition 2010.
4. Suresh Chandra. *Molecular Spectroscopy.* New Delhi: Narosa Publishing House Ltd.


## 21PPHC32 - ATOMIC AND MOLECULAR SPECTROSCOPY

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | **1.9** | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | **1.9** |
| **CO-2** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | **1.9** | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | **1.5** |
| **CO-3** | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | **2.3** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | **2.3** |
| **CO-4** | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | **2.3** | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | **2.5** |
| **CO-5** | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | **2.4** | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | **1.9** |
| **CO-6** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | **2.5** | 3 | 2 | 3 | 1 | 2 | 3 | 3 | 2 | **2.4** |
| **Average** | **3** | **2.7** | **2.5** | **2.3** | **2.7** | **2** | **1.3** | **1** | | **3** | **2** | **2.2** | **1.3** | **1.8** | **2.2** | **2.3** | **1.7** | |
| PO Mean | | | | | | | | | **2.2** | PSO Mean | | | | | | | | **2.1** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | Medium | | | | |

| SEMESTER – III | | | |
|---|---|---|---|
| **CORE – IX SOLID STATE PHYSICS- I** | | | |
| **Code: 21PPHC33** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Objectives:**

- To enable the students to employ classical and quantum mechanical theories needed to understand the physical properties of solids

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | recall about the crystal structure and degree of ordering to atom binding and packing | 1 | Re |
| CO 2 | compare the Energy Bands and the number of orbital | 5 | Un |
| CO 3 | apply the role of effective electron mass in electron dynamics | 1 | Ap |
| CO 4 | estimate the thermal ionization of donors and acceptors | 4 | Ev |
| CO 5 | describe diffraction using the reciprocal lattice | 1 | Re |
| CO 6 | deduce Bloch's theorem from the Schrödinger equation for electrons in a periodic potential | 6 | An |

| SEMESTER – III | | | |
|---|---|---|---|
| CORE - IX SOLID STATE PHYSICS- I | | | |
| **Code: 21PPHC33** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Unit I: Bonding In Solids**

Forces between atoms – Cohesive Energy – Ionic Bonding – Lattice Energy of Ionic Crystals – Evaluation of Madelung constant – Covalent Bond – Metallic Bond – Intermolecular Bond – Dispersion Bond – Dipole Bonds – Hydrogen Bonds – Properties of various Bonds.

**UnitII: Crystal Structure**

Latticerepresentation- Bravais Lattice – Unit Cell – Weigner-Sietz Cell – Miller Planes – Spacing – Crystal System – Metallic Crystal Structure: SC, BCC, FC, HCP – Structure Factor of Diamond, ZnS, NaCl, CsCl.

**Unit III:Diffraction of Waves and Reciprocal lattice**

Bragg's Law – X-ray Spectrometer – Powder Crystal method – Neutron Diffraction and Electron Diffraction – Rotating Crystal Method – The Laue Method – Reciprocal lattice – Diffraction conditions**–** Laue equations – Reciprocal lattice to SC, BCC and FCC Crystals.

**UnitIV:Crystal Imperfection and Lattice Dynamics**

Point Defect – Vacancies, Schottky and Frenkel defect – Line Imperfection – Screw Dislocation – Burger Vectors– Grain Boundaries - Tilt, Twin Boundaries – Stacking Defect Specific Heat: Dulong – Petit Law – Einstein Debye's Theory – Density of modes in one and three dimensions – Anharmonic crystal interaction: Thermal expansion, Thermal conductivity, Thermal resistivity – UMKLAPP process.

**UnitV:Electrons Theory**

Energy level – Fermi Dirac Distribution – Free electron gas in three dimensions – Heat capacity of electron gas – Electron conductivity ohms law, Matthiessen's rule – Hall effect – Wiedeman Franz law – Nearly free electron model – Bloch function –KronigPenney model.

**Text Books:**


1. Pillai S O. *Solid State Physics.* New Age International (P) Limited.Reprint, 8th Edition 2018.
2. Charles Kittel. *Introduction to Solid State Physics.* Wiley Publications.Reprint 2019.

**Books for Reference:**


1. Puri R K, Babbar V K.*Solid State Physics.* New Delhi: S Chand Publications.Reprint, First Edition 2021.
2. Palanisamy P K.*Solid State Physics.*Chennai: Scitech publications Private Ltd. Reprint 2013.
3. Ali Omar M.*Elementary Solid-State Physics Principle and Applications*. Pearson Publication. Reprint 2019.
4. Wahab M A.*Numerical Problems in Solid State Physics.*Narosa Publishing house Pvt. Ltd. Reprint 2019.


**21PPHC33 - SOLID STATE PHYSICS- I**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.38** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | **2.25** |
| **CO-2** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | **2.5** | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | **2.25** |
| **CO-3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** |
| **CO-4** | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | **2.25** | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | **2.38** |
| **CO-5** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | **2.13** |
| **CO-6** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | **2.5** | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | **2.25** |
| **Average** | **2.83** | **2.33** | **2.17** | **2.5** | **2.0** | **2.33** | **2.0** | **2.0** | | **2.5** | **2.0** | **2.17** | **2.17** | **2.17** | **2.5** | **2.17** | **2.17** | |
| PO Mean | | | | | | | | | **2.315** | PSO Mean | | | | | | | | **2.23** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - III | | | |
|---|---|---|---|
| **ELECTIVE –III A. NANO SCIENCE AND TECHNOLOGY** | | | |
| **Code:21PPHE31** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Objectives:**

- To synthesize the nanomaterial by eco-friendly methods, characterize the synthesized nanomaterials and apply in different fields for the welfare of society.
- To introduce and give an insight into the fascinating area of Nanoscience.

**Course Outcomes:**

| **CO No.** | **Upon completion of this course, students will be able to** | **PSOs addressed** | **CL** |
|---|---|---|---|
| CO 1 | recall a thorough knowledge of basic underline disciplines of nanoscience and nanotechnology | 4 | Re |
| CO 2 | explain the preparation, characterization and properties of nanomaterials | 6 | Un |
| CO 3 | analyze the types and properties of carbon nanotubes | 1 | An |
| CO 4 | assimilate existing and new concepts, methodology and researches and apply them in their academic research environment | 7 | Ev |
| CO 5 | characterise the synthesized nanomaterials by various techniques. | 5 | Ev |
| CO 6 | apply the nanomaterials in energy storage, food and in day-to-day life. | 8 | Ap |

| SEMESTER - III | | | |
|---|---|---|---|
| **ELECTIVE -III** | **A. NANO SCIENCE AND TECHNOLOGY** | | |
| **Code: 21PPHE31** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Unit I- Synthesis and Characterization of Nanoparticles**

History of Nanotechnology- Nano structures - Synthesis of oxide nano particles- Synthesis ofmetallic nano particles - Synthesis of semiconductor nanoparticles - Structural characterization (X-Ray Diffraction, Scanning Tunneling Microscopy, Atomic Force Microscopy)-Properties of Nanomaterials.

**Unit II- Carbon nanotube**

Carbon nanotube - Carbon allotropes (Diamond, Graphite, Carbon nanotubes) - Types of Carbon nanotubes – Graphene sheet to single walled nanotube - Synthesis of carbon nanotubes (Electric arc -Discharge method, Laser method, Fluidised bed CVD method, Solar production of Carbon nanotubes) -Purification and properties of Carbon nanotubes.

**Unit III-Quantum well, Quantum wire and Quantum dots**

Introduction - preparation of Quantum nanostructures - Fermi gas and Density of states –Calculation of the density of states in 1,2 and 3 dimension- Infrared detector -Quantum wire (Production,Structure, Use), Quantum dot - Application of Quantum dots – Quantum dot information storage, Quantum dot Infrared photodetectors-Quantum dot Lasers.

**Unit IV-Magneto electronics**

Magneto electronics:Nano crystalline soft magnetic materials-Permanent magnetic materials-TheoreticalBackground-Super para magnetism-Coulomb Blockade-Single electron transistor-Spintronics-Giant magneto resistance-Quantum Hall Effect-fractional Quantum Hall Effect.

**Unit V- Applications of Nanotechnology**

Applications of Nanotechnology:Chemistry and Environment - Energy applications ofNanotechnology -Information and Communication- Heavy industry - Consumer goods - Nano medicine -Tissue engineering-medical applications of molecular nanotechnology (Nanorobots, Cell repair machines, Nano nephrology)

**Text Books:**

1. Dr.GeraldinJayam S R. *Nano Physics.*

**Books for Reference:**


3. Shanmugam S. *Nanotechnology*.Chennai: MJP Publishers. 2011.
4. Parthasarathy B K. *Nanostructure and Nanomaterials.* Delhi: Isha Books. 2007.
5. Uday Kumar.*Concepts in Nano chemistry.* New Delhi: Anmol Publications Pvt. Ltd. 2013.
6. Bandyopadhyay A K.*Nano Materials*.New Age International Publishers. 2nd Edition.2012.
7. Viswanathan B.*Nano Materials*.New Delhi: Narosa Publishing House. 2013.


**21PPHE31 - NANO SCIENCE AND TECHNOLOGY**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2.875 |
| **CO-2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2.75 |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2.875 |
| **CO-4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2.875 |
| **CO-5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | 2.5 | 2.83 | 2.83 | 3 | 3 | 3 | 3 | |
| PO Mean | | | | | | | | | **3** | PSO Mean | | | | | | | | **2.89** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | Strong | | | | |

| SEMESTER - III | | | |
|---|---|---|---|
| **ELECTIVE -III** | **B. ENERGY SOURCES** | | |
| **Code: 21PPHE32** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**Objectives:**

To facilitate the students to achieve a clear conceptual understanding of energy sources and its pros and cons

**Course Outcomes:**

| **CO No.** | **Upon completion of this course, students will be able to** | **PSOs addressed** | **CL** |
|---|---|---|---|
| CO 1 | outline the technologies that are used to harness the power of solar energy | 1 | An |
| CO 2 | discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment | 5 | Un |
| CO 3 | summarize the structure of biomass. | 8 | Ev |
| CO 4 | assess economic factors affecting geothermal energy production | 5 | Ev |
| CO 5 | analyse and critically evaluate emerging geothermal technologies. | 8 | An |
| CO 6 | list the main characteristics (advantages/disadvantages) for fuel cells. | 8 | Ap |

| SEMESTER - III | | | |
|---|---|---|---|
| **ELECTIVE -III** | **B. ENERGY SOURCES** | | |
| **Code: 21PPHE32** | **Hrs/Week: 6** | **Hrs/Semester:90** | **Credits: 4** |

**UNIT I: Solar Radiation**

Introduction – Solar constant – Solar Radiation at the Earth's surface – Solar Radiation data– Estimation of Average Solar Radiation– Solar Radiation on Tilted surfaces - Solar Radiation Geometry– Solar Radiation measurements

**UNIT II: Bio Mass**

Biomass Conversion Technologies– Photosynthesis– Classification of Biogas plants– Advantages and Disadvantages of Flooting Drum plant– Advantages and Disadvantages of fixed Dome Type Plant– Selection of site for a Biogas plant -Community Biogas plants– Materials used for Biogas generation

**UNIT III: Geothermal Energy**

Estimates of Geothermal Power – Nature of Geothermal Fields – Geothermal Sources– Interconnection of Geothermal Fossil Systems– Advantages and Disadvantages of Geothermal Energy over other Energy forms– Applications of Geothermal Energy– Material selection for Geothermal Power Plants– Geothermal Expansion– Geothermal Well Drilling– Operational and Environmental Problems.

**UNIT IV: Chemical Energy: Batteries**

Introduction– Basic Battery Theory– Definitions of Fundamental Quantities– Battery Fundamental Characteristics– Different types of Battery arrangement– Classification of Batteries– Advantages of Batteries for Bulk Energy Storage.

**UNIT V: Hydrogen Energy**

Introduction– Electrolysis or the Electrolytic production of Hydrogen– Hydrogen Storage– Hydrogen Transportation– Hydrogen Technology Development in India (or) Safety and Management -Solar Energy Methods– Hydrogen as an alternative fuel for motor vehicles– Utilization of Hydrogen Gas

**Text Books:**

1. Rai G D.*Non-conventional energy sources.* Khanna Publishers. 2011.

**BookforReference:**

1. Sukhatme S P.*Solar Energy – Principles of Thermal Collection and Storage.* McGraw-Hill Education. 3rd Edition 2009.
2. Vaughn Nelson.*Introduction to Renewable Energy.* CRC Press. 1st Edition. 2011.
3. David Herak. *Biomass for energy applications.* MDPI. 1stEdition 2021.

**21PPHE32 - ENERGY SOURCES**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | **2** | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | **2.4** |
| **CO-2** | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | **2.3** | 3 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | **2.4** |
| **CO-3** | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | **1.9** | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | **2.4** |
| **CO-4** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | **2.5** | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | **2.6** |
| **CO-5** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | **2.8** | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | **2.8** |
| **CO-6** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | **2.4** | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | **2.6** |
| **Average** | **2.7** | **2.5** | **2.3** | **2.5** | **2.7** | **2.2** | **2** | **1.8** | | **3** | **1.8** | **2.2** | **2.3** | **3** | **2.3** | **2.5** | **3** | |
| PO Mean | | | | | | | | | **2.3** | PSO Mean | | | | | | | | **2.5** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | Strong | | | | |

| SEMESTER – IV | | | |
|---|---|---|---|
| **CORE X** | **QUANTUM MECHANICS – II** | | |
| **Code: 21PPHC41** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Objectives:**

- To enable students, acquire a thorough understanding about advanced quantum mechanics and their relevance in solving advanced quantum mechanical problems.

**Course Outcome:**

| **CO No.** | **Upon completion of this course, students will be able to** | **PSOs addressed** | **CL** |
|---|---|---|---|
| CO 1 | describe time independent perturbation theory and its application to the first order Stark effect in Hydrogen atom | 1 | Re |
| CO 2 | discuss time dependent perturbation theory and transition probability | 3 | Un |
| CO 3 | derive Fermi- Golden rule | 2 | An |
| CO 4 | employ WKB approximation in quantum problems | 1 | Ap |
| CO 5 | explain Dirac's equation for a free particle | 6 | Ev |
| CO 6 | apply approximation methods to solve problems | 7 | Ap |

| SEMESTER – IV | | | |
|---|---|---|---|
| **CORE X** | **QUANTUM MECHANICS – II** | | |
| **Code: 21PPHC41** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Unit I: Independent Quantum Approximation Methods I**

Stationary perturbation theory – non-degenerate case – I and II order degenerate case- perturbed harmonic oscillator – Zeeman Effect (without electron spin) – first order stark effect in hydrogen atom – Application of variation method: ground state of helium – zero point energy of one dimensional harmonic oscillator.

**Unit II: Approximation Methods II**

Application of variation method: ground state of Hydrogen atom- Deuteron problem- Vander Waals interaction- WKB Approximation – principle of the method – connection formulas of penetration of a barrier - Application of WKB method: probability of penetration of barrier – theory of alpha decay, Geiger -Nuttel law – application to bounce state – potential state.

**Unit III: Time Dependent Quantum Approximation Method & Semi-Classical Theory of Radiation**

Time dependent perturbation theory – first order perturbation – Fermi Golden rule – harmonic perturbation – second order perturbation theory – absorption and induced emission– electric dipole approximation– transition probability.

**UNIT IV: Scattering Theory**

Scattering Cross – section– Scattering amplitude- Partial waves– Scattering by central potential– Optical theorem- Ramsaur Townsend Effect- Scattering by an attractive square well potential– Breit – Wignar formula– Scattering length– Phase Shift– Integral equation– Born approximation and its validity – Laboratory and centre of mass co – ordinate systems.

**UNIT V: Relativistic Quantum Mechanics**

Klein Gordon Equation– Interpretation of Klein Gordon equation– particle in a Coloumb field– Dirac's equation for a free particle– Dirac matrices– Probability density– Negative Energy states– Spin of a Dirac particle– Magnetic Moment of the electron– Spin – Orbit interaction– Radial equation for an electron in a central potential– The Hydrogen atom– Lamb Shift.

**Text Books:**


1. L. Schiff. *Quantum Mechanics.* New Delhi: Tata Mc-Graw Hill Education Private Limited. Second reprint, 4th Edition 2019.
2. G. Aruldhas. *Quantum Mechanics.*Delhi: Prentice Hall of India Learning Private

Limited.Twenty First Print,2nd Edition 2019.
3. Satya Praksh. *Advanced Quantum Mechanics*.Meerut: Kedar Nath Ram Nath Publications. 5thEdition 2021

**Books for Reference:**

1. P. M. Mathews and K. Venkatesan.*A Text Book of Quantum Mechanics*. NewDelhi: Tata McGraw Hill Publishing Company Limited.16th reprint ,2nd Edition2007
2. R. Shankar.*Principles of Quantum Mechanics.*New York: Plenum Publishers.2nd Edition 1994.
3. J. J. Sakurai.*Modern Quantum Mechanics.* Addison- Wesley Publishing Company. Revised edition 1994.
4. S. Rajasekar and R. Velusamy.*Quantum Mechanics I: Fundamentals.*London: CRC Press. Taylor and Francis group- Boca Raton. e-book version 2015.

**21PPHC41 - QUANTUM MECHANICS – II**

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2.4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2.4 |
| **CO-2** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.6 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2.6 |
| **CO-4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **CO-5** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **CO-6** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2.5 |
| **Average** | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 | | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 | 2.5 |
| PO Mean | | | | | | | | | **2.5** | PSO Mean | | | | | | | | **2.5** |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | Strong | | | |

| SEMESTER - IV | | | |
|---|---|---|---|
| **CORE XI** | **SOLID STATE PHYSICS- II** | | |
| **Code:21PPHC42** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Objectives:**

- To enhance knowledge and understanding of the properties of condensed materials.

**Course Outcomes:**

| CO No. | Upon completion of this course, students will be able to | PSOs addressed | CL |
|---|---|---|---|
| CO 1 | understand the properties of solids | 1 | Un |
| CO 2 | define the types of Polarizability | 2 | Re |
| CO 3 | compare the magnetic properties of solid materials | 1 | An |
| CO 4 | construct the working of magnetic mirror and SQUID | 1 | Ap |
| CO 5 | solve the problems related basic crystallography. | 3 | Ap |
| CO 6 | analyse the quantum theory of magnetic materials | 7 | An |

| SEMESTER - IV | | | |
|---|---|---|---|
| **CORE XI** | **SOLID STATE PHYSICS- II** | | |
| **Code:21PPHC42** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits: 5** |

**Unit I: Dielectrics**

Review of basic formulas – Local field of an atom – Clausius-Mossotti relation – Polarizability – Electronic Polarizability – Ionic Polarizability – Orientational Polarizability – Dipolar relaxation – Dielectric loss – Dielectric breakdown – Frequency and Temperature dependence on Polarization.

**Unit II: Superconductivity**

Introduction – Properties of superconductivity – Meissner effect – Thermal properties – Type I and type II superconductors – London Equation –BCS Theory – Quantum Tunneling **–** Josephson tunneling- Applications: Magnetic mirror, SQUID, High TcSuperconductors

**Unit III: Magnetic properties of Materials**

Basic terms, Formulas – Classification of Materials – Magnetic Materials -Langevin's Theory of Diamagnetism– Langevin's Theory of Paramagnetism – Quantum Theory of Paramagnetism – Ferromagnetism – Weiss Molecular Field Theory – Ferromagnetic Domains – Domain Theory – Anti Ferromagnetism – Ferri magnetism.

**Unit IV: Ferroelectrics and Piezoelectric**

Ferroelectric crystals – Displacive Transition – Landau Theory of Phase Transition – Second Order Transition – First Order Transition – Ferroelectric Domain – Piezoelectricity.

**Unit V: Smart Materials**

Metallic Glasses: Preparation- Properties- Applications- Shape Memory Alloys (SMA): Phases of SMA- Characteristics- Properties of Ni-Ti Alloy- Applications- Advantages and Disadvantages-Bio materials: Classifications- Applications- ceramics- Bio-polymers.

**Text Books:**


1. Pillai S O.*Solid State Physics.* New Age International (P) Limited.Reprint, 8th edition. 2018.
2. Charles Kittel. *Introduction to Solid State Physics.* Wiley Publications.Reprint. 2019.
3. Dr. Mani P. *Engineering Physics II.* Chennai: Shri Dhanam Publishers. 10th Edition 2016.


**Books for Reference:**

1. Puri R K, Babbar V K. *Solid State Physics.* New Delhi: S Chand Publications. Reprint,First Edition. 2021.
2. Palanisamy P K.*Solid State Physics.*Chennai: Scitech publications Private Ltd. Reprint. 2013.
3. Wahab M A.*Numerical Problems in Solid State Physics.*Narosa Publishing house Pvt. Ltd. Reprint.2019.
4. Ali Omar M, *Elementary Solid-State Physics Principle and Applications.* Pearson Publication. Reprint. 2019.

**21PPHC42 - SOLID STATE PHYSICS- II**

| | **PO** | | | | | | | | | **PSO** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | Avg (PO) | PS O1 | PS O2 | PS O3 | PS O4 | PS O5 | PS O6 | PS O7 | PS O8 | Avg (PS O) |
| CO-1 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2.375 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.125 |
| CO-2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2.375 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.125 |
| CO-3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2.5 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2.25 |
| CO-4 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2.5 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2.375 |
| CO-5 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2.5 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2.375 |
| CO-6 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2.625 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2.25 |
| Average | 3.0 | 3.0 | 2.17 | 2.5 | 3.0 | 2.17 | 2.0 | 2.0 | | 2.5 | 2.17 | 2.67 | 2.17 | 2.17 | 2.17 | 2.17 | 2.0 | |
| PO Mean | | | | | | | | | 2.48 | PSO Mean | | | | | | | | 2.25 |
| Strength of PO Correlation | | | | Strong | | | | | | Strength of PSO Correlation | | | | | | Strong | | |

| SEMESTER - IV | | | |
|---|---|---|---|
| **CORE XII NUCLEAR AND PARTICLE PHYSICS** | | | |
| **Code:21PPHC43** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Objectives:**

- To enhance the knowledge of nuclear reactor, bombs and the elementary particles
- To extend the knowledge about different nuclear models, nuclear decay, properties of nuclear forces and elementary particles.

**Course Outcomes:**

| **CO No.** | **Upon completion of this course, students will be able to** | **PSOs addressed** | **CL** |
|---|---|---|---|
| CO 1 | list the basic atomic properties of nuclei | 1 | Re |
| CO 2 | classify the different types of nuclear reactions | 5 | Un |
| CO 3 | examine the different types of nuclear models and their properties | 6 | An |
| CO 4 | classify the types of elementary particles | 1 | Ev |
| CO 5 | distinguish the fission and fusion | 1 | An |
| CO 6 | relate the deuteron properties and reactions | 2 | Ap |

| SEMESTER - IV | | | |
|---|---|---|---|
| CORE XII NUCLEAR AND PARTICLE PHYSICS | | | |
| **Code:21PPHC43** | **Hrs/Week: 6** | **Hrs/Semester: 90** | **Credits:5** |

**Unit I: Theories of Decay**

Gamow's theory of alpha decay - General features of beta ray spectrum - Fermi's theory ofbeta decay-Forms of interaction and selection rules- parity selection rules-Parity in beta decay-The neutrino (Helicity of Neutrino) - electron capture.

**Unit II: Nuclear reaction**

Introduction of nuclear reaction-Conservation laws-Q value equation -Theories of nuclearreaction- Particle induced nuclear reactions-Electromagnetic radiation induced nuclear reactions-Compound Nucleus-Reciprocity theorem- Direct reactions- Theory of stripping andpick up reactions-Statistical theory of nuclear reaction.

**Unit III: Nuclear models & Nuclear Energy**

Liquid drop model- The Shell model- nuclear fission- Mass and energy of FissionFragments-Neutron emission in fission Process-Prompt and Delayed Neutrons-SpontaneousFission- Barrier Penetration-Theory ofSpontaneous Fission-The Nuclear Chain Reaction.

**Unit IV: Nuclear Forces**

The Deuteron -Ground state of Deuteron -Excited states of deuteron- Meson theory of nuclearforce - Nucleon-nucleon scattering - Neutron proton scattering at low energies- Spin dependenceof n-p scattering- Effective range theory of n-p scattering.

**Unit V: Elementary Particles**

Classification of elementary particles- Fundamental Interactions-Conservation laws-C-P-T Theorem-SU (2) andSU (3) symmetries-baryon octet-Meson Octet-Baryon decouplet - Gellmann-Okubo massFormula-Quarks.

**Text Books:**


1. Pandya M L and Yadav R P S. *Elements of Nuclear Physics*.Meerut : KedarNath& Ram Nath publications .Revised Reprint.2008.
2. Tayal D C.*Nuclear Physics.*Himalaya Publishing House.Reprint1985.


**Books for reference:**


1. Irving Kaplan.*Nuclear Physics.*USA:Wesley publishing company. Nineteenth Reprint, Second Edition.
2. Sharma R C.*Nuclear Physics.*Meerut : KedarNath& Ram Nath publications .6th revised edition.
3. Devanathan V.*Nuclear Physic.*New Delhi: NarosaPublishing. Revised Reprint. 2008.


## 21PPHC43 - NUCLEAR AND PARTICLE PHYSICS

| | PO | | | | | | | | | PSO | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO-1** | **PO-2** | **PO-3** | **PO-4** | **PO-5** | **PO-6** | **PO-7** | **PO-8** | **Avg** | **PSO-1** | **PSO-2** | **PSO-3** | **PSO-4** | **PSO-5** | **PSO-6** | **PSO-7** | **PSO-8** | **Avg** |
| **CO-1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 2.75 |
| **CO-3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO-6** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | **3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | 2.6 | 3 | 3 | 3 | 3 | 3 | 3 | |
| PO Mean | | | | | | | | | **3** | PSO Mean | | | | | | | | **2.95** |
| Strength of PO Correlation | | | | Medium | | | | | | Strength of PSO Correlation | | | | Strong | | | | |

## PG Department of Physics

## Overall Course Attainment Sheet for the year 2021 – 2023

| Course Code | Name of the Course | Course Outcomes | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Programme Outcomes (PO) | | | | | | | | Programme Specific Outcomes (PSO) | | | | | | | |
| | | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 | PO-7 | PO-8 | PSO-1 | PSO-2 | PSO-3 | PSO-4 | PSO-5 | PSO-6 | PSO-7 | PSO-8 |
| 21PPHC11 | Classical Mechanics | 3 | 2.7 | 2.3 | 2.8 | 2.8 | 2.3 | 2.7 | 1.2 | 3 | 2.8 | 2.2 | 2.3 | 2.3 | 2.3 | 2.7 | 1.3 |
| 21PPHC12 | Mathematical Physics I | 3 | 3 | 3 | 3 | 2.2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2.2 | 2.2 | 2 | 2.2 |
| 21PPHC13 | Electronics and Experimental methods | 3.0 | 2.67 | 2.67 | 2.0 | 2.5 | 2.17 | 2.0 | 2.17 | 2.33 | 2.0 | 2.17 | 2.0 | 2.17 | 2.0 | 2.17 | 2.17 |
| 21PPHE11 | Crystal growth &Thin films | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| 21PPHE12 | Research Methodology | 2.7 | 2.3 | 2.2 | 2.2 | 2.5 | 2 | 2.8 | 2.2 | 2.7 | 2 | 2.2 | 2.3 | 2.3 | 2.3 | 3 | 2.2 |
| 21PPHC21 | Mathematical Physics II | 3 | 3 | 3 | 3 | 2.2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2.2 | 2.2 | 2 | 2.2 |
| 21PPHC22 | Electromagnetic Theory | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2.8 | 2.6 | 3 | 2.6 | 3 | 2.6 | 2.6 | 2.6 |
| 21PPHC23 | Thermodynamics and Statistical Mechanics | 2.83 | 2.33 | 2.17 | 2.5 | 2.0 | 2.33 | 2.0 | 2.0 | 2.5 | 2.0 | 2.17 | 2.17 | 2.17 | 2.5 | 2.17 | 2.17 |
| 21PPHE21 | Bio medical Instrumentation | 2.8 | 2.8 | 2.3 | 2.7 | 2.7 | 2 | 2.2 | 1.8 | 2.8 | 2.8 | 2 | 2.5 | 2 | 1.8 | 1.8 | 2.3 |
| 21PPHE22 | Microprocessor and Microcontroller | 3 | 3 | 3 | 3 | 2.2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2.2 | 2.2 | 2 | 2.2 |
| 21PPHC31 | Quantum Mechanics – I | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 |
| 21PPHC32 | Atomic and Molecular Spectroscopy | 3 | 2.7 | 2.5 | 2.3 | 2.7 | 2 | 1.3 | 1 | 3 | 2 | 2.2 | 1.3 | 1.8 | 2.2 | 2.3 | 1.7 |
| 21PPHC33 | Solid State Physics- I | 2.83 | 2.33 | 2.17 | 2.5 | 2.0 | 2.33 | 2.0 | 2.0 | 2.5 | 2.0 | 2.17 | 2.17 | 2.17 | 2.5 | 2.17 | 2.17 |
| 21PPHE31 | Nano science and Technology | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2.5 | 2.83 | 2.83 | 3 | 3 | 3 | 3 |
| 21PPHE32 | Energy sources | 2.7 | 2.5 | 2.3 | 2.5 | 2.7 | 2.2 | 2 | 1.8 | 3 | 1.8 | 2.2 | 2.3 | 3 | 2.3 | 2.5 | 3 |
| 21PPHC41 | Quantum Mechanics – II | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 | 3 | 3 | 3 | 2.8 | 2.2 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21PPHC42 | Solid State Physics- II | **3.0** | **3.0** | **2.17** | **2.5** | **3.0** | **2.17** | **2.0** | **2.0** | **2.5** | **2.17** | **2.67** | **2.17** | **2.17** | **2.17** | **2.17** | **2.0** |
| 21PPHC43 | Nuclear and Particle Physics | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **2.6** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Average Correlation** | | **2.93** | **2.80** | **2.65** | **2.7** | **2.6** | **2.30** | **2.28** | **2.12** | **2.83** | **2.50** | **2.59** | **2.50** | **2.38** | **2.34** | **2.35** | **2.28** |
| **Mean Overall Score** | | **2.51** | **The POs and PSOs are strongly correlated with the COs of the programme** | | | | | | | | | | | | | | |