Jaya College of Arts and Science, Thiruninravur-602024.

Department of Electronics and Communication Science & Physics

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Year

- **2022-2023**

Programme Offered

- **M.Sc (PHYSICS)**

Programme Objective:

- Apply principles of basic scientific concepts in understanding, analysis& prediction of physical systems.
- Develop human resource with specialization in theoretical & experimental techniques required for career in academia, research & industry.
- Engage in lifelong learning & adapt to changing professional & societal needs.
- To impact high quality education in physical sciences.
- To prepare students to take up challenges as globally competitive physicists/ researchers in diverse area of theoretical & experimental physics.
- To make the students technically & analytically skilled.
- To provide opportunity of pursing high end research as project work.
- To give exposure to a academia ambience.
- To prepare them to take up higher studies of interdisciplinary nature.
- To impart quality education in physics to students through well designed courses of fundamental interests and of technological importance.
- To enable the students to acquire deep knowledge of fundamental aspects of all branches of physics.

Programme Outcome:

- The students will obtain good knowledge in physical sciences. They will be trained to compete national level tests like UGC-CSIR NET, JEST, GATE, etc., successfully.
- They will be prepared to take up challenges as globally competitive physicists/ researchers in diverse areas of theoretical and experimental physics.
- They will be technically and analytically skilled enough to pursue their further studies.
- They will have a sense of academia and social ethics.

- They will be capable of taking up higher studies of interdiscipklinary nature.
- They will be able to recognize the need for continuous learning and develop throughout for the professional carreer.

M.Sc. DEGREE COURSE IN PHYSICS

FIRST SEMESTER

S. NO	COURSE COMPONENTS	NAME OF COURSE	SEMESTER	INST. HOURS	CREDITS	HRS	MAX MARKS	
							CIA	EXTERNAL
1	CORE	PAPER 1 - MATHEMATICAL PHYSICS	I	6 HRS	4	3	25	75
2	CORE	PAPER 2 – CLASSICAL MECHANICS AND RELATIVITY	I	6 HRS	4	3	25	75
3	CORE	PAPER 3 - QUANTUM MECHANICS-I	I	6 HRS	4	3	25	75
4	CORE	PAPER 4 – INTEGRATED ELECTRONICS AND MICROPROCESSOR 8085	I	6 HRS	4	3	25	75
5	CORE	PAPER 5 - PRACTICAL-I *	I	6 HRS	4		40	60

SECOND SEMESTER

S. NO	COURSE COMPONENTS	NAME OF COURSE	SEMESTER	INST. HOURS	CREDITS	HRS	MAX MARKS	
							CIA	EXTERNAL
6	CORE	PAPER 6 – QUANTUM MECHANICS –II	II	6 HRS	4	3	25	75
7	CORE	PAPER 7 – ELECTROMAGNETIC THEORY AND PLASMA PHYSICS	II	6 HRS	4	3	25	75
8	CORE	PAPER 8 – PRACTICAL - II*	II	6 HRS	4		40	60
9	ELECTIVE – I	PAPER 9	II	6 HRS	4	3	25	75
10	ELECTIVE- II	PAPER 10	II	6 HRS	4	3	25	75

THIRD SEMESTER

COURSE COMPONENTS	NAME OF COURSE	INST. HOURS	CREDITS	HRS	MAX MARKS	
					CIA	EXT
CORE	PAPER 11 – Statistical Mechanics	6	4	3	25	75
CORE	PAPER 12 – Nuclear And Particle Physics	6	4	3	25	75
CORE	PAPER 13 – Computational Methods and Programming	6	4	3	25	75

CORE	PAPER 14 – Practical - III	6	4	4	40	60
Extra Disciplinary II	PAPER 15	6	4	3	25	75
Soft Skills-III		2	2	3	40	60

**** Internship will be carried out during the summer vacation of the first year and marks should be sent to the University by the College and the same will be included in the Third Semester Marks Statement.**

FOURTH SEMESTER

COURSE COMPONENTS	NAME OF COURSE	INST. HOURS	CREDITS	HRS	MAX MARKS	
					CIA	EXT
CORE	PAPER 16 – Condensed Matter Physics	6	4	3	25	75
CORE	PAPER 17 – Practical – IV ***	6	4	4	40	60
ELECTIVE- II	PAPER 18	6	4	3	25	75
ELECTIVE- III	PAPER 19	6	4	3	25	75
CORE	PAPER 20 – PROJECT ****		4		**	**
Soft Skills-IV		2	2	3	40	60

Elective I - Paper 9

Spectroscopy [OR] Nanoscience and Technology

Elective II and III -Papers 18 and 19

Any two out of the following:
1. Microprocessor and Microcontroller.
2. Material Science.
3. Advanced Spectroscopy.

Extra disciplinary Electives to be offered to M. Sc. students in Chemistry, Mathematics and other disciplines.

1. Basic Quantum Mechanics.
2. Intelligent Instrumentation.
3. Basic Material Scince.
4. Mathematical Methods.
5. Classical Dynamics.

Total credits : 90 (Core 60 + Soft-skill/Internship 10 + Electives/ED 20)

Paper 1: MATHEMATICAL PHYSICS

Course Objective:

- To train the students to solve problems related to linear vector spaces.
- To teach the use of linear differential equations in solving physical problems.
- To provide and understanding of complex variables.
- To give the basic knowledge of laplace and fourier transforms.
- To teach about an understanding of loop theory.

Course OutCome:

- The students will be able to solve different physical problems which contains matrices and a tensors.
- They will be familiarized with the differential equations and finding the solutions of Legendre, Hermite equations.
- The students will obtain knowledge of complex variables and apply them solving the taylor and Laurent expansions.
- Students will be able to solve fourier integrals and fourier transforms.
- Useful to obtain the basic knowledge of loop theory and its applications.

Syllabus:

UNIT 1: **Linear Vector Spaces and Tensors**

Linear operators – Vectors in n-dimensions – Matrix representation of vectors and operators in a basis - Linear independence, dimension - Inner product - Schwarz inequality - Orthonormal basis - Gram-Schmidt Process – Eigen values and Eigen functions of operators/matrices – Hermitian and unitary operators/matrices – Cayley-Hamilton theorem - Diagonalizing matrix. Tensors : Coordinate transformations – Contravariant and Covariant Vectors – Tensors of higher rank – Einstein's summation convention – Kronecker delta – Product rule – Quotient rule- Levi-Civita tensor in three dimensions .

UNIT 2: **Linear Differential Equations and Green's Function**
Second order linear differential equations – Wronskian - Sturm - Liouville theory - Orthogonality of eigenfunctions - Illustration with Legendre, Laguerre, and Hermite differential equations – Expansion of polynomials - Dirac delta function.
One-dimensional Green's function - Eigenfunction expansion of the Green's function - Reciprocity theorem - Sturm - Liouville type equations in one dimension and their Green's functions.

UNIT 3: **Complex Variables**
Functions of a complex variable - Single and multivalued functions - Analytic functions - Cauchy - Riemann conditions - Singular points - Cauchy's theorem and integral formulae - Taylor and Laurent expansions - Zeros and poles - Residue theorem and its applications

UNIT 4: **Laplace and Fourier Transforms**
Laplace transforms - Solution of linear differential equations with constant coefficients - Fourier integral - Fourier transforms (Infinite), Fourier sine and cosine transforms - Convolution theorems.

UNIT 5: **Group Theory**
Basic definitions - Lagrange's Theorem - Invariant subgroup - Homomorphism and Isomorphism between groups - Representation of a group - Unitary representations - Schur's lemmas - Orthogonality theorem - Character table - Simple applications to symmetry groups and molecular vibrations.

BOOKS FOR STUDY:

1. **P. K. Chattopadhyay,** 1990, *Mathematical Physics,* Wiley Eastern, Madras.
2. **G. Arfken and H. J. Weber,** 2001, *Mathematical Methods for Physicists,* 5th Edition,. Harcourt (India), New Delhi.
3. **A. W. Joshi,** 1997, *Elements of Group Theory for Physicists,* 4th Edition, New Age International, New Delhi.
4. **A. W. Joshi,** 1995, *Matrices and Tensors in Physics,* 3rd Edition, Wiley Eastern, Madras.
5. **E. Kreyszig,** 1999*, Advanced Engineering Mathematics,* 8th Edition, Wiley, New York.
6. **M. D. Greenberg,** 1998, *Advanced Engineering Mathematics,* 2nd Edition, International Ed., Prentice - Hall International, New Jersey.
7. **F. A. Cotton,** *Chemical Application of Group Theory.* 3rd Edition, John Wiley and Sons, New York.

BOOK FOR REFERENCE:

1. **Tulsi Dass** and **S. K. Sharma,** 1998**,** Mathematical Methods in Classical and Quantum Physics, Universities Press(INDIA), Hyderabad.
2. **S. Lipschutz,** 1987, *Linear Algebra,* Schaum's Series, McGraw - Hill, New York
3. **E. Butkov,** 1968, *Mathematical Physics* Addison - Wesley, Reading, Massachusetts.
4. **P. R. Halmos,** 1965, *Finite Dimensional Vector Spaces,* 2nd Edition, Affiliated East-West, New Delhi.
5. **M. Hamermesh,** 1962*, Group Theory and Its application to Physical Problems*, Addison Wesley, Reading.
6. **C. R. Wylie** and **L.C. Barrett,** 1995, *Advanced Engineering Mathematics,* 6th Edition, International Edition, McGraw-Hill, New York.
7. **W. W. Bell,** 1968, *Special Functions for Scientists and Engineers,* Van Nostrand, London.
8. **M. A. Abramowitz** and **I. Stegun (Editors),** 1972, *Handbook of Mathematical Functions* Dover, New York.

WEB SITES:

1. http://www.mpipks-dresden.mpg.de/~jochen/methods/outline/html
2. http://phy.syr.edu/~trodden/courses/mathmethods/
3. http://dmoz.org/Science/Physics/Mathematical_Physics/
4. http://www.thphys.nuim.ie/Notes/engineering/frame-notes.html
5. http://www.thphys.nuim.ie/Notes/frame-notes.html

Paper 2: CLASSICAL MECHANICS AND RELATIVITY

Course Objective:

- To define the concepts of Lagrangian and Hamiltonian formulations.
- To interpret the concepts of mechanics of rigid bodies.
- To explain canonical transformations and Poisson brackets.
- To illustrate the small oscillations.
- To formulate the concepts of relativity.

Course OutCome:

- Formulate the Lgrangian mechanics concepts and solve the problems with the help of Lagrangian mechanics.
- Compare the formulations of Hamiltonian and Lagrangian mechanics and solve the problems of classical and relativistic mechanics.
- Solve the problems of canonical transformations and Poisson brackets.
- Formulate the equations of small oscillations and finding the frequency of normal modes.
- Solve the equations of Lorentz invariance of the four product.

Syllabus:

UNIT 1: **Lagrangian and Hamiltonian Formulations**

Hamilton's variational principle - Lagrange's equations of motion – Canonical momenta – Cyclic coordinates and conservation of corresponding momenta – Legendre transformation and Hamiltonian - Hamilton's equations of motion - Two-body central force problem –Kepler Problem and Kepler's laws - Scattering by central potential - Two-particle scattering - Cross-section in lab. frame.

UNIT 2: **Mechanics of Rigid Bodies**

Rigid body motion – Kinematics – Euler angles – Infinitesimal rotations – Rate of change of a vector – Coriolis force - Dynamics - Angular momentum and kinetic energy - Moment of inertia tensor - Euler's equations of motion - Torque-free motion - Symmetrical top.

UNIT 3: **Canonical Transformation**

Canonical transformations and their generators – Simple examples - Poisson brackets – Equations of motion in Poisson bracket formalism - Symmetries and conservation laws - Hamilton-Jacobi theory - Application to harmonic oscillator problem.

UNIT 4: **Small Oscillations**

Formulation of the problem - Transformation to normal coordinates - Frequencies of normal modes - Linear triatomic molecule.

UNIT 5: **Relativity**

Lorentz transforamtions - Four vectors - Lorentz invariance of the four product of two four vectors - Invariance of Maxwell's equations - Relativistic Lagrangian and Hamiltonian for a free particle.

BOOKS FOR STUDY:

1. **H. Goldstein,** 2002, *Classical Mechanics.* 3rd Edition, C. Poole and J. Safko, Pearson Education, Asia, New Delhi.
2. **S. N. Biswas,** 1998, *Classical Mechanics,* Books and Allied Ltd., Kolkata.
3. **Upadhyaya**, 1999, *Classical Mechanics* , Himalaya Publishing Co., New Delhi.

BOOKS FOR REFERENCE:

1. **L. D. Landau** and **E. M. Lifshitz,** 1969, *Mechanics,* Pergomon Press, Oxford.
2. **K. R. Symon,** 1971, *Mechanics,* Addison Wesley, London.
3. **J. L. Synge** and **B. A. Griffith,** 1949, *Principles of Classical Mechanics,* Mc Graw-Hill, New York.
4. **C. R. Mondal**, *Classical Mechanics,* Prentice-Hall of India, New Delhi.
5. **R. Resnick,** 1968, *Introduction to Special Theory of Relativity,* Wiley Eastern, New Delhi.
6. **R. P. Feynman**, 1962, *Quantum Electrodynamics,* Benjamin, Reading, MA.

WEB SITES

1. http://astro.physics.sc.edu/selfpacedunits/unit56.html
2. http://www.phy.auckland.nz/staff/smt/453310SC.html
3. http://www.damtp.cam.ac.uk/user/tong/dynamics.htm

4. http://farside.ph.utexas.edu/teaching/301/lectures/lectures.html
5. http://www.lancs.ac.uk/depts/physics/teaching/py332/phys332.htm

Paper 3: QUANTUM MECHANICS - I

Course Objective:

- To define the wave functions and derive the Schroedinger equation.
- To demonstrate particle in a box problem.
- To formulate the concepts of Hilbert space and explain the schroedinger and Heisenberg and interaction pictures.
- To formulate the approximation methods to solve real problems.
- To explain the angular momentum concepts and wave functions.

Course OutCome:

Students will be to

- Derive Schroedinger equation and will be able to define eigen values and eigen functions.
- Solve square well potential and simple harmonic oscillator problems.
- Explain symmetry and conservation laws and also parity and time reversal.
- Apply the approximation methods to solve simple harmonic oscillator and hydrogen molecule problems.
- Derive Clebsch-Gordan coefficients.

Syllabus:

UNIT 1: **Basic formalism**
Interpretation and conditions on the wave function - Postulates of quantum mechanics and the Schroedinger equation - Ehrenfest's theorem- Stationary states - Hermitian operators for dynamical variables - Eigenvalues and eigenfunctions - Uncertainty principle.

UNIT 2: **One Dimensional Problems and Three Dimensional Problems**
Particle in a box - Square-well potential - Barrier penetration - Simple harmonic oscillator - Ladder operators method.
Orbital angular momentum and spherical harmonics - Central forces and reduction of two-body problem - Particle in a spherical well - Hydrogen atom.

UNIT 3: **General Formalism**
Hilbert space - Dirac notation - Representation theory - Co-ordinate and momentum representations - Time evolution - Schroedinger, Heisenberg and Interaction pictures-

Symmetries and conservation laws - Unitary transformations associated with translations and rotations - Parity and time reversal.

UNIT 4: **Approximation methods**
Time-independent perturbation theory for non-degenerate and degenerate levels - Variation method, simple applications - WKB approximation - Connection formulae (no derivation) - WKB quantization rule - Application to simple harmonic oscillator - Hydrogen molecule, covalent bond and hybridization.

UNIT 5: **Angular Momentum and Identical particles**
Eigenvalue spectrum from angular momentum algebra - Matrix representation - Spin angular momentum - Non-relativistic Hamiltonian including spin - Addition of angular momenta - Clebsch - Gordan Coefficients.Symmetry and anti-symmetry of wave functions - Spin and Pauli matrices.

BOOKS FOR STUDY:

1. **P. M. Mathews** and **K. Venkatesan**, *1976, A Text book of Quantum Mechanics,* Tata McGraw-Hill, New Delhi.
2. **L. I. Schiff**, *1968, Quantum Mechanics,* 3rd Edition, International Student Edition, MacGraw-Hill Kogakusha, Tokyo.
3. **V. Devanathan,** 2005, *Quantum Mechanics,* Narosa Publishing House, New Delhi.

BOOKS FOR REFERENCE:

1. **E. Merzbacher**, 1970, *Quantum Mechanics* 2nd edition, John Wiley and Sons, New York.
2. **V. K. Thankappan**, *1985, Quantum Mechanics*, 2nd Edition, Wiley Eastern Ltd, New Delhi.
3. **P. A. M. Dirac**, 1973, *The Principles of Quantum Mechanics*, Oxford University Press, London.
4. **L. D. Landau** and **E. M. Lifshitz**, 1976, *Quantum Mechanics* Pergomon Press, Oxford.
5. **S. N. Biswas**, 1999, *Quantum Mechanics,* Books And Allied Ltd., Kolkata.
6. **G. Aruldhas**, 2002, *Quantum Mechanics*, Prentice Hall of India, New Delhi.
7. **A. Ghatak and S. Lokanathan**, *Quantum Mechanics: Theory and Applications,* 4th Edition, Macmillan India.
8. **J. S. Bell, Gottfried** and **M.Veltman**, 2001, *The Foundations of Quantum Mechanics* World Scientific, Singapore.
9. **R. P. Feynman, R. B. Leighton, and M. Sands**, 1998, *The Feynman Lectures on Physics*, Vols. 3, Narosa, New Delhi.
10. **V. Devanathan,** 1999, *Angular Momentum Techniques in Quantum Mechanics,* Kluwer Academic Publishers, Dordrecht.

WEB SITES

1. http://www.netsa.org.lk/OcwWeb/Physics/index.htm
2. http://www.theory.caltech.edu/people/preskill/ph229/
3. http://www.nscl.msu.edu/~pratt/phy851/lectures/lectures.html
4. http://walet.phy.umist.ac.uk/QM/LectureNotes/

5. http://www.ks.uiuc.edu/Services/Class/PHYS480/
6. http://www.mat.univie.ac.at/~gerald/ftp/book-schroe/index.html
7. http://people.deas.harvard.edu/~jones/ap216/lectures/lectures.html
8. http://www.netsa.org.lk/OcwWeb/Chemistry/5-73Introductory-Quantum-Mechanics-IFall2002/LectureNotes/index.htm
9. http://www.glue.umd.edu/~fivel/
10. http://www.phys.ualberta.ca/~gingrich/phys512/latex2html/phys512.html
11. http://www.eas.asu.edu/~vasilesk/EEE434.html
12. http://minty.caltech.edu/Ph125a/
13. http://walet.phy.umist.ac.uk/QM/LectureNotes/

PAPER – 4 : INTEGRATED CIRCUITS AND MICROPROCESSOR 8085 UNIT

Course Objective:

- To impart the knowledge on operational amplifier and timer circuits.
- To have an idea of D/A and A/D coverters.
- To teach about the understanding of combinational and sequential logic circuits.
- To give the basic knowledge of programming of 8085 and interfacing of devices.
- To provide the understanding of 8085 interfacing applications.

Course OutCome:

Students will be able to

- Define an operational amplifier and a 555 timer circuit.
- Familiarize with the binary weighed, dual slope, ADC and successive approximation method.
- Gain knowledge of working of encoder, decoder, RS, D, JK, MS flip-flops and various counters.
- Learn about the memory interfacing EPROM, PPI and 8255.
- Design D/A converter and D/A converter.

Syllabus:

UNIT – I Linear ICs and Applications

Operational Amplifier : Solution of simultaneous equations and differential equations – Instrumentation amplifier – Log and Antilog amplifiers – Analog multiplication and division.

Generation of square, triangular and sine waves – pulse generation – Schmitt trigger – Active filters (Second order Butterworth design).

Timer 555 : Internal architecture and working – Schmitt trigger – Astable and monostablemultivibrators – Phase Locked Loop.

UNIT – II Data Counters

Binary weighted and R/2R ladder DAC – Accuracy and resolution – Dual slope DAC- ADC – Simultaneous conversion – Counter method – Successive approximation.

UNIT – III Combinational and Sequential Logic Circuits

4-bit binary adder and subtracter- Encoder and Decoder – Multiplexer and Demultiplexer.

Flip – Flops : RS, D-type, JK and M/S JK Flip-Flops, Counters – Asynchronous , Synchronous and Modulus counters – BCD counter – Shift registers – Ring counter – Johnson counter.

UNIT – IV 8085 Programming, Peripheral Devices and their Interfacing

Instruction set -Addressing modes – Programming techniques – Memory mapped I/O scheme – I/O mapped I/O scheme – Memory and I/O interfacing – Data transfer schemes – Interrupts of

8085 – Programmable pheripheral interface (PPI) – Control group and control word – Programmable DMA controller – Programmable interrupt controller – Programmable communication interface – Programmable counter/interval timer.

UNIT – V 8085 Interfacing Applications

Seven segment display interface – Interfacing of Digital to Analog converter and Analog to Digital converter – Stepper motor interface – Measurement of electrical quantities (voltage and current) – Measurement of physical quantities (temperature and strain).

BOOKS FOR STUDY :

1. **Millman** and **Halkias**, *Integrated Electronics*.
2. **R. A. Gaekward**, 1994, *OpAmps and Integrated Circuits,* EEE.
3. **Taub** and **Shilling**, 1983, *Digital Integrated Electronics*, Mc Graw Hill, New Delhi.
4. **Malvino and Leech**, *Digital Electronics*
5. **J. Millman**, 1979, *Digital and Analog Circuits and Systems*, Mc Graw Hill, London.
6. **R. S. Gaonkar**, 1997, *Microprocessor Architecture, Programming and Application with the 8085*, 3rd Edition, Penram International Publishing, Mumbai**.**
7. **B. Ram,***Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, New Delhi.*
8. **V. Vijayendran**, 2002, *Fundamentals of Microprocessor 8085 – Architecture, Programming and Interfacing*, Chennai.

BOOKS FOR REFERENCE :

1. **S. M. Sze**, 1985, *Semiconductor Devices – Physics and Technology*, Wiley, New York.

2. **R. F. Coughlin** and **F.F. Driscol**, 1996 *OpAmp and linear integrated circuits,* Printice Hall of India, New Delhi.
3. **M.S. Tyagi**, *Introduction to Semiconductor Devices*, Wiley, New York.
4. **P.Bhattacharya**, 2002, *Semiconductor Optoelectronics Devices*, 2nd Edition. Printice Hall of India, New Delhi.
5. **B. Somanath Nair**, 2002, *Digital Electronics And Logic Design*, Printice Hall of India, New Delhi.
6. **R.L. Boylestad** and **L.Nashelsky**, *Electronic Devices and Circuit Theory*, 8th Edition, Pearson Education.

Paper 5: PRACTICAL - I

Syllabus:

Part – 1A : Electronics and Microprocessor 8085 **(Any TEN Experiments)**

1. FET CS amplifier – Design, Frequency response, input impedance, output impedance
2. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
3. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
4. Design of a Schmitt trigger circuit using IC 741 f or a given hysteresis – application of squarer.
5. Design of a square wave oscillator using IC 741 – Triangular wave oscillator.
6. Construction of pulse generator using the IC 741 – application as frequency divider.
7. OP-Amp. – 4 bit Digital to Analog converter [R / 2R ladder network].
8. Study of R-S, clocked R-S and D-flip flops using NAND / NOR gates.
9. Study of J-K, D and T flip flops using IC 7476 / 7473.
10. Arithmatic operations using IC 7483 – 4 bit binary addition and subtraction.
11. IC 7490 as a scalar and display using IC 7447.

Microprocessor 8085

12. 8 –bit addition and subtraction, multiplication and division.
13. Sum of a set of N data (8 – bit numbers), Picking up the smallest and largest number in an array. Sorting in ascending and descending order.
14. Code conversion (8 – bit numbers) : (a) Binary to BCD and (b) BCD to Binary.
15. Addition of multibyte numbers, Factorial.

Part – 1B : General (Any FIVE Experiments)

1. Cornu's Method – Young's modulus and Poisson's ratio by Elliptic fringes.
2. Stefan's constant.
3. Bang gap energy – Thermistor / Semiconductor.
4. Hydrogen spectrum – Rydberg's constant.
5. Thickness of the enamel coating on a wire – by diffraction.
6. Coefficient of linear expansion – Air wedge method.

7. Permittivity of a liquid using an RFO.
8. L-G plate.
9. Lasers : Study of laser beam parameters.
10. Arc spectrum : Copper.

Paper 6: QUANTUM MECHANICS II

Course Objective:

- To define scattering amplitude and explain their importance.
- To formulate time dependent perturbations theory and study approximation methods.
- Introducing Klein-Gorden equation Dirac equation to study relativistic quantum mechanics.
- Explain the derivation of Dirac equation and study Feynman's theory.
- Apply the ideas of second quantization and study commutation relations.

Course OutCome:

- To explain scattering theory and S wave.
- To apply perturbation theory and deducing selection rules for dipole radiation.
- Interpret negative energy states.
- Explain four vector.
- Demonstrate commutation relations of operators.

Syllabus:

UNIT 1: **Scattering Theory**
Scattering amplitude - Cross sections - Born approximation - Partial wave analysis -Effective range theory for S-wave - Transformation from centre of mass to laboratory frame.

UNIT 2: **Perturbation Theory**
Time dependent perturbation theory - Constant and harmonic perturbations - Transition probabilities - Adiabatic approximation - Sudden approximation - The density matrix - Spin density matrix and magnetic resonance - Semi-classical treatment of an atom with electromagnetic radiation - Selection rules for dipole radiation.

UNIT 3: **Relativistic Quantum Mechanics**
Klein-Gordon equation - Dirac equation - Plane-wave solutions - Interpretation of negative energy states - Antiparticles - Spin of electron - Magnetic moment of an electron due to spin - Energy values in a Coulomb potential.

UNIT 4: **Dirac Equation**
Covariant form of Dirac equation - Properties of the gamma Matrices - Traces -Relativistic invariance of Dirac equation – Probability density-current four vector – Bilinear covariants - Feynman's theory of positron (Elementary ideas only without propagation formalism).

UNIT 5: **Second Quantization**

Second quantization of Klein-Gordon field - Creation and annihilation operators - Commutation relations - Quantization of electromagnetic field - Creation and annihilation operators - Commutation relations.

BOOKS FOR STUDY:

1. **P. M. Mathews** and **K. Venkatesan**, *1976, A Text book of Quantum Mechanics,* Tata McGraw-Hill, New Delhi.
2. **L. I. Schiff**, *1968, Quantum Mechanics,* 3rd Edition, International Student Edition, MacGraw-Hill Kogakusha, Tokyo.
3. **E. Merzbacher**, *1970, Quantum Mechanics*, 2nd edition, John Wiley and Sons, New York.
4. **V. K. Thankappan**, *1985, Quantum Mechanics*, 2nd Edition, Wiley Eastern Ltd, New Delhi.
5. **J.D. Bjorken** and **S.D. Drell**, 1964, *Relativistic Quantum Mechanics*, MacGraw-Hill New York.
6. **V. Devanathan,** 2005, *Quantum Mechanics,* Narosa Publishing House, New Delhi.

BOOKS FOR REFERENCE:

1. **P. A. M. Dirac**, 1973, *The Principles of Quantum Mechanics*, Oxford University Press, London.
2. **L. D. Landau** and **E. M. Lifshitz**, 1958 *Quantum Mechanics*, Pergomon Press, London.
3. **S. N. Biswas**, 1999, *Quantum Mechanics*, Books and Allied, Kolkata.
4. **G. Aruldhas**, 2002, *Quantum Mechanics*, Prentice-Hall of India, New Delhi.
5. **J. S. Bell, Gottfried** and **M.Veltman**, 2001, *The Foundations of Quantum Mechanics*, World Scientific.
6. **V. Devanathan,** 1999, *Angular Momentum Techniques in Quantum Mechanics,* Kluwer Academic Publishers, Dordrecht.

Paper 7: ELECTROMAGNETIC THEORY AND PLASMA PHYSICS

Course Objective:

- To understand the concepts of electrostatics and application of boundary condition.
- To learn the ideas of magneto statics and the energy.
- To grasp the concepts of Maxwell’s equation.
- To study the wave propagation in conducting and non-conducting media.
- To acquire knowledge of electron plasma oscillations.

Course OutCome:

- To define boundary conditions.
- To explain magnetic moment, torque on a current element in external field.

- To derive wave equations.
- To discuss propagation of waves in a rectangular waves in a rectangular wave guide.
- To explain Debye's shelding problems.

Syllabus:

UNIT 1: **Electrostatics**
Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar co ordinates – Examples of solutions for boundary value problems.
Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarisability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

UNIT 2: **Magnetostatics**
Biot-Savart Law - Ampere's law - Magnetic vector potential and magnetic field of a localised current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magnetostatic energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetised sphere.

UNIT 3: **Maxwell Equations**
Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution- Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

UNIT 4: **Wave Propagation**
Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide.
Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole.

UNIT 5: **Elementary Plasma Physics**
The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfven waves and magnetosonic waves**.**

BOOKS FOR STUDY:

1. **D. J. Griffiths,** 2002, *Introduction to Electrodynamics,* 3rd Edition, Prentice-Hall of India, New Delhi.
2. **J. R. Reitz, F. J. Milford and R. W. Christy,** 1986, *Foundations of Electromagnetic Theory,* 3rd edition, Narosa Publication, New Delhi.
3. **J. D. Jackson,** 1975, *Classical Electrodynamics,* Wiley Eastern Ltd. New Delhi.
4. **J. A. Bittencourt,** 1988, *Fundamentals of Plasma Physics,* Pergamon Press, Oxford.

BOOKS FOR REFERENCE:

1. **W. Panofsky** and **M. Phillips, 1962,** *Classical Electricity and Magnetism,* Addison Wesley, Lodon.
2. **J. D. Kraus** and **D. A. Fleisch,** 1999, *Electromagnetics with Applications,* 5^{th} Edition, WCB McGraw-Hill, New York.
3. **B. Chakraborty**, 2002, *Principles of Electrodynamics,* Books and Allied, Kolkata.
4. **R. P. Feynman, R. B. Leighton** and **M. Sands**, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa, New Delhi.

WEB SITES:

1. http://www.plasma.uu.se/CED/Book/index.html
2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html
3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html
4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/

Paper 9/10: SPECTROSCOPY

Course Objective:

- To learn about the intricacies of microwave spectroscopy.
- To understand the details of Normal coordinates analysis.
- To know about the vibrations of diatomic, triatomic and polyatomic molecules.
- To learn about Raman scattering.
- To grasp complete knowledge of NMR & ESR spectroscopy.

Course OutCome:

- Able to deal with hyper fine structure and quadrupole moment.
- To differentiate between C2V and C3V point group.
- Learn to know how to operate a IR spectrometer.
- To explain phase transitions.
- Identifies the crystal defects.

Syllabus:

UNIT 1: **Microwave Spectroscopy**

Rotational spectra of diatomic molecules - Polyatomic molecules - Linear and symmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Experimental techniques - Stark effect.

UNIT 2: **Normal Coordinate Analysis**
Selection rules for Raman and IR vibrational normal modes – Normal for Raman and IR activity C2V and C3V point groups – Representation of Molecular Vibrations in Symmetry co-ordinates – Normal coordinate analysis for H2O molecule

UNIT 3: **Infrared Spectroscopy**
Vibrations of diatomic and simple polyatomic molecules - Anharmonicity – Fermi Resonance – Hydrogen Bonding – Normal Modes of Vibration in a crystal – Solid State Effects – Interpretation of Vibrational Spectra – Instrumentation techniques – FTIR spectroscopy

UNIT 4: **Raman Scattering**
Vibrational and Rotational Raman spectra – Mutual Exclusion principle – Raman spectrometer – Polarization of Raman Scattering light. Structure Determination through IR and Raman spectroscopy – Phase transitions – Resonance Raman Scattering

UNIT 5: **NMR and ESR Spectroscopy**
Quantum theory of NMR – Bloch equations – Design of CW NMR Spectrometer – Principle and block diagram of PT NMR – Chemical Shift – Application to molecular structure.
Quantum Theory of ESR – Design of ESR Spectrometer – Hyperfine Structure – Anisotropic systems – Triplet state study of ESR – Applications – Crystal defects -Biological studies

BOOKS FOR STUDY:

1. **C. N. Banwell** and **E. M. McCash**, 1994, *Fundamentals of Molecular Spectroscopy,* 4th Edition TMH, New Delhi.
2. **G. Aruldas**, 2001, *Moleclar Structure and Spectroscopy,* Prentice Hall of India Pvt. Ltd. New Delhi.
3. **D. N. Satyanarayana,** 2004, *Vibrational Spectroscopy and Applications,* New Age International Publication

BOOKS FOR REFERENCE:

1. **D. D. Jyaji** and **M. D Yadav** 1991, *Spectroscopy*, Amol Publications
2. **Atta ur Rahman,** 1986, *Nuclear Magnetic Resonance*, Spinger Verlag.
3. **D. A. Lang,** *Raman Spectroscopy,* Mc Graw-Hill International
4. **Raymond Chang,** 1980, *Basic Principles of Spectroscopy* Mc Graw-Hill Kogakusha, Tokyo.

ENERGY PHYSICS

Course Objective:

- To utilize judiciously the natural resources.
- To understand the ocean energy.
- To benefit from the wind energy.
- To learn hoe effectively we can generate Bio-mass energy.

- To understand designing of solar powers.

Course OutCome:

- Learn renewable energy sources.
- May design instruments to generate electricity from tidal waves.
- Learn the functionality of wind mills.
- May change over to Bio gas from LPG.
- Develop devices running on solar power.

Syllabus:

UNIT – I

Introduction to energy sources - Energy sources and their availability – prospects of renewable energy sources – Energy from other sources – chemical energy – Nuclear energy – Energy storage and distribution.

UNIT – II

Energy from the oceans – Energy utilization – Energy from tides – Basic principle of tidal power – utilization of tidal energy.

UNIT – III

Basic principles of wind energy conversion – power in the wind – forces in the Blades – Wind energy conversion – Advantages and disadvantages of wind energy conversion systems (WECS) Energy storage – Applications of wind energy.

UNIT – IV

Energy from Biomass: Biomass conversion Technologies – wet and dry process – Photosynthesis.

Biogas Generation: Introduction – basic process and energetic – Advantages of anaerobic digestion – factors affecting bio digestion and generation of gas - biogas from waste fuel – properties of biogas-utilization of biogas.

UNIT – V

Solar radiation and its measurements – solar, cells : Solar cells for direct conversion of solar energy to electric powers – solar cell parameter – solar cell electrical characteristics – Efficiency – solar water Heater – solar distillation – solar cooking – solar green house.

BOOKS FOR REFERENCE:

1. Non-conventional sources of energy by G.D. Rai, 4th edition, Khanna Publishers, New Delhi (1996)
2. Energy Technology by S. Rao and Dr.Parulekar.
3. John Twidell and Tony weir, Renewable energy resources, Taylor and Francis group, London and Newyork.
4. M.P. Agarwal, Solar energy, S. Chand and Co.,
5. A.B. Meinel and A.P. Meinal, Applied solar energy.
6. Solar energy, principles of thermal collection and storage by S.P. Sukhatme 2nd edition, Tata McGraw-Hill publishing co. Ltd., New Delhi (1997).

BASIC MATERIAL SCIENCE

Course Objective:

- To provide the students with basic knowledge of material science.
- To understand variety of materials available.
- To distinguish between materials based on their structures and properties.
- To learn electron theory of metals.
- To understand electrical and magnetic properties of materials.

Course OutCome:

- Get to know different classes of materials used in engineering application.
- Get to choose right material for right applications.
- Develop knowledge on nucleation and growth.
- Differentiate between metals, insulators and semi conductors.
- Learn piezo, pyro and ferro electric materials.

Syllabus:

Unit 1 – **Introduction:**
Classification of materials – materials for engineering applications – different types of chemical bonds – crystal structure s of important engineering materials – crystal imperfection and types of imperfections

Unit 2 – **Phase diagram:**
Systems – components – phases – solid solutions – Hume-Rothery's rule and Gibbs' Phase rule – Lever rule – construction of phase diagrams – eutectic, peritectic, eutectoid and peritectoid systems

Unit 3 – **Phase transformation:**
Mechanism – nucleation and growth – applications of phase transformations – cooling, casting, solidification and heat treatment – TTT diagram – martensitic transformation

Unit 4 – **Electron theory of metals:**
Classical free electron theory – density of states – electron energies in a metal – energy band and Fermi energy in solids – distinction between metals, insulators and semiconductors on the basis of Fermi level – effect of temperature on Fermi level

Unit 5 – **Electrical and magnetic properties of materials:**
Electrical resistivity and conductivity of meterials – dielectric materials – electrical polarization – piezo, pyro and ferroelectric materials – electrostriction – classification of magnetic materials – domain structure – magnetostriction – soft and hard magnetic materials

BOOKS FOR STUDY:

1. **V. Raghavan**, 2003, *Materials Science and Engineering*, 4th Edition, Printice-Hall India, New Delhi (for units 2, 3, 4 and 5)
2. **G.K. Narula, K.S. Narula** and **V.K. Gupta**, 1988, Materials Science, Tata McGraw- Hill
3. **M. Arumugam**, 2002, *Materials Science*, 3rd revised Edition, Anuradha Agencies

BOOKS FOR REFERENCE:

1. **Lawrence H. Van Vlack**, 1998, *Elements of Materials Science and Engineering*, 6th Edition, second ISE reprint, Addison-Wesley
2. **H. Iabch and H.Luth**, 2001, *Solid state Physics – An introduction to principles of Material Science*, 2nd Edition, Springer

Paper 11: STATISTICAL MECHANICS

Course Objective:

- To understand thermodynamics potentials.
- To learn phase space, entropy and gibb's paradox.
- To grasp the concepts of ensembles.
- To understand classical and quantum statistics & Bose- Eienstein condensation.
- To learn I sing model & fluctuations students

Course OutCome:

Students should be able to

- Use various ensembles theories to calculate thermodynamic properties of different systems.
- Compute properties of systems behaving as ideal Fermi gas or ideal Bose gas.
- Classify transitions as first order or second order.
- Reproduce the exact solution of Ising model- Dimension.
- Understand Liou-ville's theorem.

Syllabus:

UNIT 1: **Phase Transitions**

Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics.
Order parameters - Landau theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

UNIT 2: **Statistical Mechanics and Thermodynamics**

Foundations of statistical mechanics - Specification of states of a system - Microcanonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the microcanonical ensemble - Entropy of mixing and Gibb's paradox.

UNIT 3: **Canonical and Grand canonical Ensembles**

Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.

UNIT 4: **Classical and Quantum Statistics**

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzman statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.

UNIT 5: **Real Gas**, **Ising Model and Fluctuations**

Cluster expansion for a classical gas - Virial equation of state – Calculation of the first virial coefficient in the cluster expansion - Ising model - Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in one-dimension.
Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion - Langevin theory - Fluctuation-dissipation theorem - The Fokker-Planck equation.

BOOKS FOR STUDY:

1. **S.K.Sinha** , 1990 , *Statistical Mechanic*s , Tata Mc Graw – Hill, New Delhi.
2. **B. K. Agarwal and M. Eisner,** 1998, *Statistical Mechanics,* Second Edition New

Age International, New Delhi.

1. **J. K. Bhattacharjee,** 1996, *Statistical Mechanics*: An Introductory Text, Allied Publication, New Delhi.
2. **F. Reif,** 1965, *Fundamentals of Statistical and Thermal Physics,* Mac Graw-Hill, New York.
3. **C. Kittel, 1987,** *Thermal Physics,* 2nd edition, CBS Publication, New Delhi.
4. **M. K. Zemansky,** 1968, *Heat and Thermodynamics,* 5th edition, Mc Graw-Hill New York.

BOOKS FOR REFERENCE:

1. **R. K. Pathria,** 1996, *Statistical Mechanics,* 2nd edition, Butter Worth-Heinmann, New Delhi.
2. **L. D. Landau and E. M. Lifshitz,** 1969, *Statistical Physics,* Pergomon Press,Oxford.
3. **K. Huang,** 2002, *Statistical Mechanics,* Taylor and Francis, London
4. **W. Greiner, L. Neise** and **H. Stoecker,** *Thermodynamics and Statistical Mechanics,* Springer Verlang, New York.
5. **A. B. Gupta, H. Roy**, 2002, *Thermal Physics*, Books and Allied, Kolkata.
6. **A. Kalidas, M. V. Sangaranarayanan**, *Non-Equilibrium Thermodynamics*, Macmllan India, New Delhi.
7. **M. Glazer** and **J. Wark**, 2001, *Statistical Mechanics*, Oxford University Press, Oxford.
8. **L. P. Kadanoff**, 2001, *Statistical Physics - Statics, Dynamics and Renormalization*, World Scientific, Singapore.
9. **F. W. Sears** and **G. L. Salinger**, 1998, *Thermodynamics, Kinetic Theory and Statistical Thermodynamics,* 3rd Edition, Narosa, New Delhi.

WEB SITES

1. http://www.nyu.edu/classes/tuckerman/stat.mech/lectures.html
2. http://www.abo.fi/~mhotokka/mhotokka/lecturenotes/sm.html
3. http://www-f1.ijs.si/~vilfan/SM/cont.html
4. http://web.mit.edu/8.334/www/lectures/
5. http://cs.physics.sunysb.edu/verbaarschot/html/lectures/phy306-05/notes.html

Paper 12: NUCLEAR AND PARTICLE PHYSICS

Course Objective:

- To impart the knowledge of nuclear interactions and nuclear scattering.
- To acquire knowledge about nuclear models and angular momentum.
- To provide the knowledge nuclear reactions and resonance scattering.
- To have a good understanding of Nuclear decay, γ- decay and selection rules.
- To have an elementary idea of particles and their classification.

Course OutCome:

Students will have

- An idea developed about the nucleus.
- A concept &nature of nuclear force.
- Learn about the method and analyzing of scattering process.
- An idea about the interaction particles with matter.
- An understanding nature, interaction etc of the elementary particles.

Syllabus:

Unit 1 – **Nuclear interactions**

Nucleon-nucleon interaction – Tensor forces – Meson theory of nuclear forces – Yukawa potential – Nucleon-Nucleon scattering – Effective range theory – Spin dependence of nuclear forces – Charge independence and charge symmetry of nuclear forces – Isospin formalism

Unit 2 – **Nuclear reactions**

Types of reactions and conservation laws – Energetics of nuclear reactions –Dynamics of nuclear reactions – Q-value equation – Scattering and reaction cross sections – Compound nucleus reactions – Direct reactions – Resonance scattering – Breit-Wigner one level formula

Unit 3 – **Nuclear Models**

Liquid drop model – Bohr-Wheeler theory of fission – Experimental evidence for shell effects – Shell model – Spin-orbit coupling - Magic numbers – Angular momenta and parities of nuclear ground states – Qualitative discussion and estimate of transition rates – Magnetic moments and Schmidt lines – Collective model of Bohr and Mottelson

Unit 4 – **Nuclear decay**

Beta decay – Fermi theory of beta decay – Shape of the beta spectrum – Total decay rate - Mass of the neutrino – Angular momentum and parity selection rules – Allowed and forbidden decays – Comparative half-lives – Neutrino physics – Non-conservation of parity – Gamma decay – Multipole transitions in nuclei – Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism

Unit 5 – **Elementary particle physics**

Types of interaction between elementary particles – Hadrons and leptons – Symmetries and conservation laws – Elementary ideas of CP and CPT invariance – Classification of hadrons – SU(2) and SU(3) multiplets – Quark model - Gell-Mann-Okubo mass formula for octet and decuplet hadrons – Charm, bottom and top quarks

BOOKS FOR STUDY

1. **K. S. Krane**, 1987, *Introductory Nuclear Physics*, Wiley, New York.
2. **D. Griffiths**, 1987, *Introduction to Elementary Particle Physics*, Harper & Row, New York.
3. **R. R. Roy** and **B.P. Nigam**, 1983, *Nuclear Physics*, New age Intl. New Delhi.

BOOKS FOR REFERENCE:

1. **H. A. Enge**, 1983, *Introduction to Nuclear Physics*, Addison-Wesley, Tokyo
2. **Y. R. Waghmare**, 1981, *Introductory Nuclear, Physics*, Oxford-IBH, New Delhi.
3. **Ghoshal**, *Atomic and Nuclear Physics*, Vol. 2
4. **J. M. Longo**, 1971, *Elementary particles*, McGraw-Hill, New York.
5. **R. D. Evans**, 1955, *Atomic Nucleus*, McGraw-Hill, New York.
6. **I. Kaplan**, 1989, *Nuclear Physics*, Narosa, New Delhi
7. **B. L. Cohen**, 1971, *Concepts of Nuclear Physics*, TMH, New Delhi
8. **M. K. Pal**, 1982, *Theory of Nuclear Structure*, Affl. East-West, Chennai.
9. **W. E. Burcham** and **M. Jobes**, 1995, *Nuclear and Particle Physics*, Addison-Wesley, Tokyo.

WEB SITES

1. http://ocw.mit.edu/OcwWeb/Physics/8-701Spring 2004/Lecture notes
2. http://faraday.physics.utoronto.ca/General Interest/D.Bailey/SubAtomic/ Lectures/ Lect.html

NUMERICAL METHODS AND COMPUTER PROGRAMMING

Course Objective:

- To teach the ways of solving equations.
- To train them to solve linear systems equations.
- To teach them the concepts of inter- polation and curve fitting.
- To instruct them to calculate integrals & differentials.
- To learn the programming with FORTRAN/C.

Course OutCome:

Students should be able to

- Solve roots of non-linear algebraic equations.
- Effectively use eigen values & eigen vectors of materials.
- Enrich the given set of data points using inter-polation methods.
- Like Newton forward & backward inter polation.
- Numerically differentiate & integrate expressions.

Syllabus:

CRYSTAL GROWTH

Course Objective:

The students are enable to

- Understand the fundamentals of crystal growth & nucleation.
- Analyze the low temperature method of crystal growth.
- Understand the melt growth technique of crystal growing.
- Be aware of thin films formation through vapour deposition.
- Introduce gel growth and flux growth.

Course OutCome:

Students will be able to

- Grow crystal using a simple technique.
- Understand laboratory technique of growing crystal.
- Understand thye High level technique of melt growth.
- Understand the formation of thin film mechanism.
- Analyze Gel growth and flux growth.

Syllabus:

UNIT – I NUCLEATION (12 Hours)

Nucleation concept – Kinds of nucleation – Classical theory of nucleation - Spherical nucleus – Induction period – Measurement - Heterogeneous nucleation – Equilibrium concentration of embryos – Energy of formation of a critical nucleus - Free energy of formation of a critical heterogeneous cap shaped and disc shaped nuclei –Nucleation rate.

UNIT – II CRYSTAL GROWTH THEORIES (12 Hours)

Surface energy theory – Diffusion theory – Adsorption layer theory – Volmer theory – Bravais theory – Kossel theory – Two dimensional nucleation theory – Free energy of formation of a two dimensional nucleus – Possible shapes – Rate of nucleation

UNIT – III CRYSTAL GROWTH FROM SOLUTION (12 Hours)

Low temperature solution growth – Solution and Solubility – Preparation of solution - Principle of low temperature solution growth - Mier's solubility diagram – Measurement of solubity – Measurement of Ostwald-Mier's metastable zone width – Achievement of supersaturation.

Crystal Growth methods – Slow cooling method – Holden's rotary crystallizer - Mason Jar method – Slow evaporation method – Johnson's rotating crystal method - Temperature gradient method – Kruger and Fink U tube method.

UNIT – IV MELT GROWTH AND VAPOUR GROWTH (12 Hours)

Growth of crystal from melt – Bridgman method – Czochralski method – LEC growth of III – V materials – Verneuil method – Phase diagram principle of zone refining - Zone melting method.

Physical vapour deposition – Chemical vapour deposition – Open and closed systems – Physical and thermo - chemical factors affecting growth process.

UNIT – V GEL GROWTH AND FLUX GROWTH (12 Hours)

Gel growth – Different gel medium – Specific gravity – Silica gel – Agar gel – Basic growth procedure – Single diffusion technique – Double diffusion technique – Reaction method – Chemical reduction method.

High temperature solution growth (Flux growth) – Principle of flux growth – Slow cooling method – Slow evaporation method – Top seeded solution growth.

BOOKS FOR STUDY

1. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution"
2. J. C. Brice, " Crystal Growth Processes"
3. J. C. Brice, "The Growth of Crystals from Melt"
4. D. Elwell and H. J. Scheel, "Crystal Growth from High Temperature Solution" 5. Heinz K. Henish, "Crystal Growth in Gels", Cambridge University Press, 1973.

BOOK FOR REFERENCE

1. P. Ramasamy and F. D. Gnanam, "UGC Summer School Notes", 1983.
2. P. SanthanaRaghavan and P. Ramasamy, "Crystal Growth Processes", KRU Publications.

CLASSICAL DYNAMICS

Course Objective:

The students are enable to

- To distinguish between inertia frame of reference and non inertia frame of reference.
- To know how to impose constraints on a system in order to simplify the methods to be used in solving physics problems.
- To know the importance of concepts such as generalized co-ordinates and constrained motion.
- To find the linear approximation to any dynamical system near equilibrium and also know how to derive & solve the wave equation for small oscillations.
- To learn about cyclic coordinates & applications of Hamilton's canonical- equations of motion.

Course OutCome:

Students will be able to

- Learn about Lagrangian and Hamiltonian formulation of classical mechanics.
- Understand about motion of a particle under central force field.
- Have a deep understanding of transformation equation.
- Know about transformation to normal modes & linear triatomic molecule.
- Understand about four vectors, various physical quantities in for vector notation and their transformation.

Syllabus:

UNIT 1: **Principles of classical mechanics**
Mechanics of a single particle – mechanics of a system of particles – conservation laws for system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work

UNIT 2: **Lagrangian formulation**
D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion

UNIT 3: **Hamiltonian formulation**

Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field

UNIT 4: **Small oscillations**
Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule

UNIT 5: **Special theory of relativity**
Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations

BOOKS FOR STUDY:

1. **H. Goldstein**, 2002, *Classical Mechanics*, 3 rd Edition., Pearson edu.
2. **Upadhyaya**, *Classical Mechanics*, Himalaya Publshing. Co. New Delhi.
3. **R. Resnick,** 1968, *Introduction to Special Theory of Relativity,* Wiley Eastern, New Delhi.

BOOKS FOR REFERENCE:

1. **K. R. Symon,** 1971, *Mechanics,* Addison Wesley, London.
2. **S. N. Biswa**s, 1999, *Classical Mechanics*, Books & Allied, Kolkatta.
3. **Gupta** and **Kumar**, *Classical Mechanics*, Kedar Nath.
4. **T.W.B. Kibble**, *Classical Mechanics*, ELBS.
5. **Greenwood**, *Classical Dynamics*, PHI, New Delhi.

CONDENSED MATTER PHYSICS

Course Objective:

- To relate crystal structure to symmetry recognize the correspondence between real & reciprocal space.
- Acquire knowledge of the behavior of electronics in solid based on classical & quantum theories.
- To become familiar with the different types of magnetism & magnetism based phenomena.
- To develop an understanding of the dielectric properties & ordering of dipoles in ferroelectrics.
- To get familiarized with the different parameters associated with super conductivity & theory of superconductivity.

Course OutCome:

- Able to correlate the x-ray diffraction pattern for a given crystal structure based on the corresponding reciprocal lattice.
- Able to explain how the predicted electronic properties of solids differ in the classical free electron theory, quantum free electron theory & nearly free electron model.
- Able to explain various magnetic phenomena on the exchange interactions.
- Able to differentiate between ferroelectric, anti-ferroelectric, piezoelectric and pyro electric materials.
- Able to differentiate between type-I and type-II superconductors & their theories.

Syllabus:

UNIT 1: **Crystal Physics**
Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc) – Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

UNIT 2: **Lattice Dynamics**
Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes.

UNIT 3: **Theory of Metals and Semiconductors**
Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect .

UNIT 4: **Magnetism**
Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature.

UNIT 5: **Superconductivity**

Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors.

Theoretical Explanation: Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs - BCS Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors - SQUIDS.

BOOKS FOR STUDY:

1. **C. Kittel**, 1996, *Introduction to Solid State Physics,* 7th Edition, Wiley, New York.
2. **M. Ali Omar**, 1974, *Elementary Solid State Physics - Principles and Applications,* Addison - Wesley
3. **H. P. Myers**, 1998, *Introductory Solid State Physics,* 2nd Edition, Viva Book, New Delhi.

BOOKS FOR REFERENCE:

1. **N. W. Aschroft** and **N. D. Mermin**, *Solid State Physics,* Rhinehart and Winton, New York.
2. **J. S. Blakemore**, 1974 , *Solid state Physics,* 2nd Edition, W.B. Saunder, Philadelphia
3. **A. J. Dekker**, *Solid State Physics*, Macmillan India, New Delhi.
4. **H. M. Rosenburg**, 1993, *The Solid State,* 3rd Edition, Oxford University Press, Oxford.
5. **S. O. Pillai**, 1997, *Solid State Physics*, New Age International, New Delhi.
6. **S. O. Pillai**, 1994, *Problems and Solutions in Solid State Physics,* New Age International, New Delhi.
7. **S. L. Altmann**, *Band Theory of Metals*, Pergamon, Oxford.
8. **J. M. Ziman**, 1971, Principles *of the Theory of Solids*, Cambridge University Press, London.
9. **C. Ross-Innes** and **E. H. Rhoderick,** 1976, *Introduction to Superconductivity,* Pergamon, Oxford.
10. **M. Tinkham**, *Introduction to Superconductivity*, McGraw-Hill, New York.
11. **J. P. Srivastava,** 2001, *Elements of Solid State Physics,* Prentice-Hall of India, New Delhi.

WEB SITES

1. http://www.physics.brocku.ca/courses/4p70/
2. http://www.physics.brocku.ca/courses/4p70/
3. http://web.mit.edu/afs/athena/course/6/6.732/www/texts.html
4. http://jas.eng.buffalo.edu/education/semicon/fermi/functionAndStates/functionAndStates.html
5. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html
6. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html

MICROPROCESSOR 8086 AND MICROCONTROLLER 8051

Course Objective:

- To study the architecture of 8086 microprocessor.
- To understand 8051 microcontroller concepts in hardware.
- To learn assembly language programming in 8051 microcontroller.
- To know different interrupt concepts in 8051 programming.
- To develop an in depth knowledge in interfacing techniques to implement in external world.

Course OutCome:

- Describe the architecture of 8086 microprocessor.
- Implement the features of 8051 microcontroller and microcontroller hardware.
- Analyze assembly language programming.
- Implement interrupt program in various applications.
- Perform interfacing of I/O devices with 8051 microcontroller.

Syllabus:

UNIT - I **8086 Architecture and Programming**

8086 Architecture – Min.Mode, Max.Mode – Software Model – Segmentation- Segmentation of address – Pipe line Processing.

Addressing Modes – Instruction Set- Constructing Machine Code – Instruction Templates for MOV Instruction– Data Transfer Instructions– Arithmetic, Logic, Shift, rotate instructions- Flag Control instructions- Compare, Jump Instructions– Loop and String instructions -Assembly programs- Block move, Sorting, Averaging, Factorial – Code Conversion : Binary to BCD , BCD to Binary.

UNIT - II **8051 Microcontroller Hardware**

Introduction – Features of 8051 – 8051 Microcontroller Hardware : Pin-out of 8051, Central Processing Unit (CPU), Internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input / Output pins, Ports and Circuits – External data memory and Program memory : External program memory, External data memory.

UNIT - III **8051 Instruction Set And Assembly Language Programming**

Addressing modes – Data moving (Data transfer) instructions : Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions : byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions : Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions : Jump and Call program range, Jump, CALL and subroutines – Programming.

UNIT - III **Interrupt Programmig**

8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts, Software triggering of interrupt.

UNIT - IV **Interfacing To External World**

Interfacing keyboard : Simple keyboard interface, Matrix keyboard interface – Interfacing displays : Interfacing seven segment LED displays, Interfacing LCD display – Interfacing DAC to 8051– Interfacing ADC to 8051 – Interfacing sensors – Interfacing stepper motor.

BOOKS FOR STUDY

1. A. P. Godse and D. A. Godse, “Microprocessors & its Applications”, Technical Publications, Pune,
2. Kenneth Ayala, “The 8051 Microcontroller”, Third Edition, Delmar Cengage Learning, 2005.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, “The 8051 Microcontroller and Embedded Systems”, Second Edition, Pearson Education 2008.
4. W.A. Triebel and Avatar Singh, *The 8086 /8088 Microprocessors-Programming, Software, Hardware and application,* Prentice Hall of India, New Delhi. (Unit 2)

BOOKS FOR REFERENCE

1. Douglas V. Hall : - Microprocessors and Interfacing programming andHardware(Tata Mc Graw Hill) (Unit 1)
2. B. Brey, 1995, *Intel Microprocessors 8086/8088, 80186,80286,80486,80486*, Architecture, Programming and Interfacing
3. Yu – Cheng and Glenn A. Gibson, *The 8086 / 8088 family Architecture, Programming and Design*, Prentice-Hall of India.
4. Muhammed Ali Mazidi and Janice Gillespie Mazidi, 2004, *The 8051 Microcontroller and Embedded Systems*, Fourth Indian Reprint, Pearson Education.
5. V. Vijayendran, 2002, *Fundamentals of Microprocessor –8086-Architecture, Programming (MASM) and interfacing*, Viswanathan, Chennai.