Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE , SATARA

(AN AUTONOMOUS INSTITUTE)

Syllabus for Master of Science Part – I

1. **Title:** Physics

2. **Year of Implementation:** The syllabus will be implemented from June, 2018 onwards.

3. **Preamble**:

This syllabus is framed to give sound knowledge with understanding of Physics to postgraduate students at first year of two years of M.Sc. degree course.

The goal of the syllabus is to make the study of Physics popular, interesting and encouraging to the students for higher studies including research.

The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

4. General Objectives of the Course:

1. The students are expected to understand the fundamentals, principles, physical concepts and recent developments in the subject area.
2. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in physics.
3. It is expected to inspire and boost interest of the students towards Physics as the main subject.
4. To develop the power of appreciations, the achievements in Physics and role in nature and society.
5. To enhance student sense of enthusiasm for Physics and to involve them in an intellectually stimulating experience of learning in a supportive environment.

5. Duration: The course shall be a full time.

6. Pattern: Semester examination.

7. Medium of Instruction: English.

8.Structure of Course:

Semester-I

Paper-I Mathematical Methods in Physics (MPT 101)

Objectives:

1. The students are expected to understand the fundamentals, principles, physical concepts and recent developments in the subject area.
2. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in physics.
3. It is expected to inspire and boost interest of the students towards Physics as the main subject.

Unit I- Matrix Algebra and Eigenvalue Problems: (15)

Matrix multiplication – Inner product, direct product, Diagonal matrices, trace, matrix Inversion, Gauss-Jordon Inversion theorem, problems (Rajput 735 – 45, Iyengar 1.1 – 1.26). Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors, CaylyHamilton Theorem and applications, similar matrices and diagonalizable Matrices, Eigenvalues of some Special Complex Matrices, Quadratics forms, problems. (Iyengar 2.1 to 2.35).

Unit II- Complex Variables: (15)

Definition of Complex Numbers and variables, Equality of Complex variables, Complex Algebra, Conjugate Complex Numbers, Geometrical representation of Complex Number, Geometrical representations of the sum, difference, product and quotient of Complex Number, Cauchy-Rieman Conditions, Analytic functions, Multiply connected regions, Cauchy Theorem, Cauchy Integration formula, problems (Rajput – 283 – 314).

Unit III-Calculus of Residues & Special function: (15)

Singularities- Poles, Branch Points, Calculus of Residues-Residues Theorem, Cauchy Principle value, Pole Expansion of Meromorphic Functions, Product expansion of entire Functions, problems (Rajput 326 – 384). Special function(only definitions)- Legendre Hermit, Laguerre function, Generating function, Recurrence relations and Their differential equations, Orthogonality properties. Bessel's function of first kind, Spherical Bessel function, Associated Legendre function, Spherical harmonics.

Unit IV- Fourier- Series, Integral, and Transform: (15)

Definition, Evaluation of Coefficients of Fourier Series (Cosine and Sine Series), Dirichelet's Theorem, Graphical representation of a square wave function, Extension of interval, Complex form of Fourier Series, Properties of Fourier Series (Conversions, Integration, Differentiation, Parseval's Theorem). Fourier Integral- exponential form, Applications of Fourier Series analysis in Physics (Square wave, Full wave rectifier, Expansion of Raman Zeta function) (Rajput 527 – 561). Fourier transform, Inversion theorem, exponential transform Example: Full wave train, Uncertainty principle [Arfken 931-946].

Text Books:

1. Rajput B S, Mathematical Physics, Pragati Prakashan (Meerat) 1999
2. Iyengar S R K, Jain R K , Mathematical Methods, Narosa, 2006
3. Arfken And Weber, Mathematical Methods For Physicists 6th Edition, Academic Press, 2005

Reference Book:

1. Riley K F, Hobson M P and Bence S J, Mathematical Methods for Physics and Engineering, Cup, 1997
2. Introduction to mathematical physics: Balsubramanyam

Learning Outcomes :

Unit – I :

1. Student should able to define Inner product, direct product, Diagonal matrices, trace, matrix Inversion
2. Student should able to understand Gauss-Jordon Inversion theorem.
3. Students should able to define Eigenvalues and Eigenvectors
4. Student should able to understand Theorem and applications of matrices.

Unit – II :

1. Understanding of Complex Algebra, Conjugate Complex Numbers and their sum ,Difference, Product and quotient.
2. Student should able to define Complex Numbers and variables, Equality of Complex variables
3. Student should able to understand Cauchy Theorem.

Unit – III :

1. Understanding of Calculus of Residues-Residues Theorem.
2. Student should able to understand Pole Expansion of Meromorphic Functions, Product expansion of entire Functions, problems.
3. Student should able to define Bessel's function of first kind.

Unit – IV :

1. Student should able to understand Dirichelet's Theorem.

2. Understanding of Fourier Series and its complex form, integral form and exponential form.

3. Student should able to understand Fourier transform, Inversion theorem.

Semester-I
Paper-II Classical Mechanics(MPT 102)

Unit1:Rotatioanl motion and central force problem **(15)**

Inertial forces in rotating frames, Larmour precision, electromagnetic analogy of inertial forces ,effect of coriolis force, Focoult's pendulum, two body central force ,equation of motion and first integral, Kepler's laws, Keplers problem, central analysis of orbit, Artificial satellites.
Rutherford scattering: Scattering formulae, Different scattering cross section (Rana and Joag P.118-175 Goldstein p.70-77, 94-101, 105-113)

Unit 2:Lagrangian formulation **(15)**

Introduction, Lagrangian equation of motion, properties of kinetic energy function, theorem on total energy, generalized momenta, cyclic coordinates, integral of motion, Jocobi integral and energy conservation , concept of symmetry, invariance under Galilean transformation, velocity dependent potential. (Rana and Joag P.55-92)

Unit 3: Hamilton's formulation and Variational Principle
(15)

Hamilton's function and Hamilton's equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian of relativistic particles and light rays, Variational Principle, Euler's equation, applications of Variational Principle, shortest distance problem , Brachistrochrone problem.
(Rana and Joag P.183-196, 222-224)

Unit 4: Canonical Transformation and Poisson Brackets
(15)

Generating function, condition for conical transformation and problems, Definition of Poisson Brackets, Identities, Poisson theorem, Jacobi-Poisson Brackets, Jacobi Identity, Invariance of Poisson Brackets under conical transformation. (Rana and Joag P. 236-253, 262-269)

Reference Books :

1.Classical Mechanics– H Goldstein 2ND Edition (Addison Wesley 1980)
2.Classical Mechanics –N C Rana and P S Joag 2013 (Tata McGraw Hill 1991)
3.Classical Mechanics– R G Takwale and P S Puranik (Tata McGraw Hill 1991)
4.Classical Mechanics–Gupta , Kumar and Shrama (Pragati Prakashan 2000)
5.Classical Mechanics– J.C Upadhyaya, Himalaya Publishing House.

Learning Outcomes :

Unit – I :

1. Student should able to define Inertial forces, Larmour precision, coriolis for forces
2. Student should able to understand Focoult's pendulum, two body central force.
3. Students should able to understand Kepler's laws
4. Student should able to understand Rutherford scattering: Scattering formulae, Different scattering cross section.

Unit – II :

1. Understanding of inertial Lagrangian equation of motion.
2. Student should able to understand generalized momenta, cyclic coordinates
3. Student should able to understand Jocobi integral and energy conservation , concept of symmetry, invariance under Galilean transformation.

Unit – III :

1. Student should able to understand Hamilton's function and Hamilton's equation of motion,
2. Understanding of configuration space, phase space and state space ,
3. Student should able to understand Variational Principle, Euler's equation.
4. Student should able to understand Brachistrochrone problem.

Unit – IV :

1. Student should able to define Generating function.
2. Student should able to define Poisson Brackets, Identities, Poisson theorem, Jacobi-Poisson Brackets, Jacobi Identity.
4. Student should able to understand concept Invariance of Poisson Brackets.

Semester-I

Paper –III Quantum Mechanics - I(MPT 103)

Unit 1: Fundamental Concepts and Formalism (15)

Why Q.M? Revision; Inadequacy of classical mechanics; sequential Stern Gerlach experiment, analogy with polarization of light, ket and bra spaces and inner products, operators, the associative axiom base kets and matrix representations, measurements, observables and the uncertainty relations, change of basic position momentum and translation; wave function in position and momentum space. (Sakurai P.13-72)

Unit 2: Quantum Dynamics (15)

Time evolution and Schrödinger equation, the Schrödinger verses the Heisenberg picture, simple harmonic oscillation, Schrödinger wave equation - one dimensional problems, well and barriers, harmonic oscillator by Schrödinger equation and by operator method.

Uncertainty relation of x and p states with minimum uncertainty product; general formalism of wave mechanics; commutation relations. (Sakurai P. 80-120)

Unit 3: Angular Momentum (15)

Eigen values and Eigen functions of L^2 and L_z operators, Ladder operators L_+ and L_-, Paulli Theory of spins (Paulli's Matrices), angular momentum as a generator of infinitesimal rotations, Matrix representation of Jin | jm > basis. Addition of angular momenta, Computation of Clebsch-Gordon Coefficients in simple cases (J_1=1/2; J_2=1/4) (Sakurai P. 164-229)

Unit 4: Time Independent Perturbation Theory (15)

Introduction of perturbation theory, Eigen value of energy and Eigen function in the first order approximation (the case of a system with non degenerate energy levels), Application to unharmonic oscillator. (Sakurai P. 297-315)

Text and Reference Books:

1. Modern Quantum Mechanics, 30th Edition by J.J. Sakurai
2. Introduction to Quantum Mechanics by A.C.Philips Wiley publications
3. Introduction to Quantum Mechanics by Ghatak Lokhanthan
4. Introduction to Quantum Mechanics by David J Griffith
5. Quantum Mechanics concept and application by N Zettili (Taylor and Francis)
6. Introduction to Quantum mechanics by Venkatesan and Mathews TMH
7. Quantum Mechanics by L. I Schiff, (McGraw-Hill)

Learning outcomes:

Unit – I:

1. Student should able to define and understand ket and bra spaces and inner products, operators
2. Student should able to understand kets and matrix representations.
3. Students should able to understand wave function in position and momentum space.

Unit – II :

1. Understanding of Time evolution and Schrödinger equation.
2. Student should able to understand Schrödinger wave equation - one dimensional problems, well and barriers.
3. Student should able to understand Uncertainty relation of x and p states.

Unit – III :

1. Student should able to define and understand Eigen values and Eigen functions of L^2 and L_z operators.
2. Understanding of Paulli Theory of spins.
3. Student should able to understand Computation of Clebsch-Gordon Coefficients in simple cases ($J_1=1/2$; $J_2=1/4$).
4. Student should able to define Central forces.

Unit – IV:

1. Student should able to understand Eigen value of energy and Eigen function in the first order approximation.
2. Understanding of application to unharmonic oscillator.

Semester I
Paper-IV Atomic and Molecular Physics(MPT 104)

UnitI:Vector atom model for two valence electron system (15)

Types of coupling- ll, ss, LS or Russiel Sounder's coupling, Pauli Exclusion principle and terms arising from different states, coupling schemes for two valence electron system, r-factors for LS coupling, Lande interval rule, jj-coupling and r-factors for jj coupling, branching rules, Selection rules for LS and jj coupling and intensity relations. (H. E. White P.114-210)

UnitII: Zeeman Effect, Paschen-Back effect and Stark effect (15)

The magnetic moment of the atom, Zeeman effect for two-electrons, Intensity rules for Zeeman effect, Paschen-Back effect for two-electrons, Stark effect of hydrogen, weak field stark effect in hydrogen, strong field Stark effect in hydrogen, origin of hyperfine structure, Principles of Resonance spectroscopy (ESR and NMR) (H. E. White P.215-235)

UnitIII: Electronic and Microwave Spectroscopy (15)

Classification of molecules: Linear, symmetric tops, spherical tops, asymmetric tops

Rotational spectra: the rigid diatomic molecule, non-rigid rotator, spectrum of a non-rigid rotator**,** techniques and instrumentations of microwave spectroscopy, chemical analysis by microwave spectroscopy.

Electronic spectra of diatomic molecules, electronic structure of diatomic molecule, chemical analysis by electronic spectroscopy.

(Banwell P. 40-69, 197, 215, 234)

Unit IV: IR spectroscopy (15)

The vibrating diatomic molecule: the energy of diatomic molecule and Morse function, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating-rotator, techniques and instrumentation of infra-red spectroscopy, chemical analysis by infra-red spectroscopy. (Banwell P.72-111)

Reference books:

1) Introduction to Atomic Spectra – H.E. White, McGraw Hill (1934).
2) Fundamentals of Molecular Spectroscopy, Edn. 3 – C.N. Banwell, Elaine M Maccash sTata McGraw Hill (1983). Chapter 2, 3 and 6
3) Spectra of Diatomic Molecules, Vol. I – G. Herzberg, N.J.D. van Nostrand (1950).
4) Introduction to Molecular Spectroscopy – G.M. Barrow, McGraw Hill (1962).

5) Molecular Spectroscopy – J.M. Brown, Oxford University Press (1998).
6) Molecular Structure and spectroscopy-G. Aruldas EEE PHI(2010)

Learning outcomes :

Unit – I :

1. Student should able to understand ll, ss, jj, LS or Russiel Sounder's coupling
2. Student should able to understand coupling schemes for two valence electron system.
3. Students should able to understand Selection rules for LS and jj coupling and intensity relations

Unit – II:

1. Understanding of Zeeman effect for two-electrons, Paschen-Back effect for two-electrons,
2. Student should able to understand Stark effect of hydrogen.
3. Student should able to understand origin of hyperfine structure.
4. Understanding of concept principles of Resonance spectroscopy (ESR and NMR)

Unit – III:

1. Student should able to understand electronic spectra and rotational of diatomic molecules chemical
2. Understanding of Classification of molecules Linear, symmetric tops, spherical tops, asymmetric tops
3. Student should able to understand instrumentations of microwave spectroscopy.

Unit – IV :

1. Student should able to understand vibrating diatomic molecule the simple harmonic oscillator,
2. Understanding of techniques and instrumentation of infra-red spectroscopy.
3. Student should able to understand chemical analysis by infra-red spectroscopy.

Semester II
Paper-V Quantum Mechanics-II(MPT 201)

Unit I: Time dependent Perturbation (15)

Time-dependent perturbation theory, Non degenerate case and applications, Degenerate case and applications, Stark effect, Fermi's Golden rule. (Sakurai P.327 – 357)

Unit II: Approximation methods (15)

Variational method : basic principle, Application to their ground state of Hydrogen atom and first excited state of harmonic oscillator, WKB method and its applications. (Sakurai P.316 – 326, Zettili P. 515-529)

Unit III: Scattering Theory (15)

The Lippman-Schwinger Equation, Born Approximation, Optical Theorem, Method of Partial Waves, Low energy scattering and bound state, Resonance scattering, Scattering by hard sphere, Coulomb scattering. (Sakurai P.391- 452)

Unit IV: Theory of Radiation (15)

Semi classical theory of radiation; Transition probability for absorption and induced emission; Electric dipole and forbidden transitions, Selection rules. (Zettili P. 586-596)

Text and Reference Books:

1. Modern Quantum Mechanics, 30th Edition by J.J. Sakurai
2. Introduction to Quantum Mechanics by A.C.Philips Wiley publications
3. Introduction to Quantum Mechanics by Ghatak Lokhanthan
4. Introduction to Quantum Mechanics by David J Griffith
5. Quantum Mechanics concept and application by N Zettili, 2nd Edition (Taylor and Francis)
6. Introduction to Quantum mechanics by Venkatesan and Mathews TMH
7. Quantum Mechanics by L. I Schiff, (McGraw-Hill)

Learning Outcomes:

Unit – I :

1. Student should able to understand Time-dependent perturbation theory.
2. Student should able to understand Non degenerate case and applications
3. Students should able to understand Stark effect, Fermi's Golden rule.

Unit – II :

1. Understanding of Variational method.
2. Student should able to understand problem of Hydrogen atom.
3. Student should able to understand WKB method and its applications.

Unit – III :

1. Student should able to understand the Lippman-Schwinger Equation, Born Approximation,
2. Understanding of Optical Theorem.
3. Student should able to understand Low energy scattering and bound state, Resonance scattering, Scattering by hard sphere, Coulomb scattering.

Unit – IV :

1. Student should able to understand semi classical theory of radiation
2. Understanding of transition probability for absorption and induced emission;
3. Student should able to understand electric dipole and forbidden transitions, Selection rules.

Semester II
Paper –VI Statistical Mechanics(MPT 202)

Unit I: Introduction of Statistical Mechanics and thermodynamics (15)

Specification of state of system, Macroscopic and microscopic states, phase space, Statistical ensemble, postulate of equal priori probability. Fluctuations of physical quantities, Statistical Equilibrium,

Thermodynamics -Thermodynamic Laws and its applications, Thermodynamic Functions – Entropy, Free energy, Internal Energy, Enthalpy (definitions), Contact between statistics and thermodynamics – Entropy in terms of microstates, change in entropy with volume and temperature.

(Reif P. 48-60, 91,122,123, B. B. Laud P.47-57)

Unit II: Statistical Ensembles Theory (15)

Micro canonical Ensemble– Micro canonical distribution, Entropy and specific heat of a perfect gas, Entropy and probability distribution.

Canonical Ensemble– Canonical Distribution, partition function, Calculation of free energy of an ideal gas, Thermodynamic Functions, Energy fluctuations, Applications of Canonical Ensemble.

Grand Canonical Ensemble– Grand Canonical distribution, Thermodynamic Functions, Number and Energy fluctuations. (Laud P. 59-76)

Unit III: Formulation of Quantum Statistics (15)

Distinction between MB, BE and FD distributions, Quantum distribution functions – Boson and Fermion gas and their Boltzmann limit, Partition function.

Ideal Bose gas, Bose Einstein Condensation, Phonon gas, Liquid He4: Second Sound. Ideal Fermi gas: Weakly and strongly degenerate, Electron gas: Free electron theory of metals, Pauli paramagnetism. (Reif P.331-393, L. D. Landau P.158-183, B.B. Laud p.125-143)

Unit IV: Phase Transitions and Critical Phenomenon (15)

Phase Transitions, Conditions for phase equilibrium, First order Phase Transition: Clausius - Clayperon equation, Second order phase transition, The critical indices. (B.B. Laud p.189-200)

Text and Reference books:

1.Statistical Mechanics Theory and Applications, S K Sinha, Tata McGraw-Hill, (1990).
2. Introduction to Statistical mechanics by Saxena and Gupta
3. Introduction to Statistical mechanics, B B Laud, Macmillan, N Delhi, (1981).
4. Statistical Mechanics by R K Pathria, Pergamon press (1972).
5. Fundamentals of Statistical and thermal Physics 1985 F Reif, McGraw-Hill (1965).

6. Statistical Physics, L D Landau and E M Lifshitz, Pergamon press (1958).

Learning Outcomes :

Unit – I :

1. Student should able to define specification of state of system, Macroscopic and microscopic states, phase space, Statistical ensemble.
2. Student should able to understand Fluctuations of physical quantities, Statistical Equilibrium.
3. Students should able to understand Thermodynamic Laws and its applications.
4. Student should able to define Entropy, Free energy, Internal Energy, Enthalpy.

Unit – II:

1. Understanding of distinction Micro canonical, Ensemble Canonical Ensemble and Grand Canonical
2. Student should able to understand Micro canonical distribution, Canonical Distribution and its applications
3. Student should able to understand Thermodynamic Functions, Number and Energy fluctuations

Unit – III:

1. Student should able to understand Distinction between MB, BE and FD distributions, Quantum ,
2. Understanding of Boson and Fermion gas, Phonon gas, Electron gas
3. Student should able to understand Bose Einstein Condensation ,Pauli paramagnetism.

Unit – IV:

1. Student should able to understanding Phase Transitions, Conditions for phase equilibrium, First order Phase Transition:, Second order phase transition.
2. Understanding of Clausius - Clayperon equation.
3. Student should able to understand the critical indices.

Semester II
Paper-VII Electrodynamics(MPT 203)

Unit I: Time Varying Fields (15)

Time dependents field, faradays law for stationary and moving media, Maxwell's displacement current, Differential and Integral forms of Maxwell's equations, Maxwell's equation for moving medium, microscopic and macroscopic forms in Maxwell's equation. (B. B. Laud 144-165)

Unit II: Maxwell's Equations and E.M. Waves (15)

Conservation of the bound charge and current densities, E.M. wave equations in waveguide of the arbitrary cross section: TE and TM modes; Rectangular and circular waveguides, hybrid modes, concept of LP modes (Griffiths P. 425-431)

Unit III: Time –Dependent Potentials and Fields (15)

Scalar and vector potentials: coupled differential equations, Gauge transformations: Lorentz and Coulomb Gauges, Retarded Potentials, Lienard –Wiechert Potentials, Fields due to a charge in the arbitrary motion. (Griffiths P. 436-465, Jackson P.237-240)

Unit IV: Radiation from Accelerated Charges and Radiation Reaction (15)

Fields of charge in uniform motion, applications to linear and circular motions: cyclotron and synchrotron radiations, Power radiated by point charge – Larmor's formula, Angular distribution of radiated power, Cerenkov radiation and Bremsstrahlung (qualitative treatments). Radiation Reaction: criteria for validity, Abraham –Lorentz formula, Physical basis of radiation reaction – self force. (S.P. Puri P.12.1-12.30)

Text and Reference books:

1. Classical Electrodynamics –S.P. Puri, Narosa Publication 2011
2. Introduction to Electrodynamics – D.J. Griffiths (Prentices- Hall 2002 (4th Edn)

3. Foundation of E.M. Theory- J.R. Reitz, F.J. Milford & R.W. Christy (Narosa Publication House 3rd edition 1993)
4. Classical Electrodynamics – J. D. Jackson (Wiley Eastern 2nd edition)
5. Electromagnetics - B. B. Laud Wiley Eastern Publication 1983)

Learning Outcomes : Unit – I :

1. Student should able to define time dependents field,
2. Student should able to understand faradays law for stationary and moving media, Maxwell's displacement current.
3. Students should able to Maxwell's equation for moving medium and its microscopic and macroscopic forms

Unit – II:

1. Understanding of Conservation of the bound charge and current densities.
2. Student should able to understand idea of waveguide
3. Student should able to understand rectangular and circular waveguides, hybrid modes, concept of LP modes

Unit – III:

1. Student should able to define Scalar and vector potentials.
2. Understanding of Gauge transformations: Lorentz and Coulomb Gauges.
3. Student should able to understand Retarded Potentials, Lienard –Wiechert Potentials.

Unit – IV:

1. Student should able to understand concept Fields of charge in uniform motion.
2. Understanding of cyclotron and synchrotron radiations
3. Student should able to understand power radiated by point charge – Larmor's formula
4. Student should able to understand Cerenkov radiation and Bremsstrahlung, Abraham –Lorentz formula

Semester II
Paper-VIII Condensed matter Physics – I(MPT 204)

Unit I: Crystal growth and Imperfections in crystals (15)

Crystal growth:- Nucleation and growth- Homogeneous and heterogeneous nucleation- classification of crystal growth techniques - melt growth, Bridgman, Czochralski techniques.

Imperfections : Classification of imperfections- point defects - schottky and freckle defects- Expressions for equilibrium defect concentrations o Colour centers- Production of colour centres- line defects- Dislocations- Edge and Screw dislocations- Burger Vector- Estimation of dislocation densities- Mechanism of creep- Experimental determination of creep activation energy.

(Wahab P. 150-190)

Unit II: Dielectrics and Ferroelectrics (15)

Dielectrics: Introduction, Dipole moment, various types of polarization, electronic, ionic and orientation polarization, Langevin's theory, Lorentz field, Clausius- Mosotti equation, measurement of dielectric constant, Applications of dielectrics.

Ferroelectrics : Piezo, pyro and ferroelectric crystals, Spontaneous polarization, classification and properties of ferroelectrics, ferroelectric domains- oxygen ion displacement theory Application of ferroelectrics. (Wahab P. 455-480, Kittel P.453-482)

Unit III: Ferromagnetism and Anti-ferromagnetism (15)

Ferromagnetism: Introduction, Weiss molecular field theory-Temperature dependence of spontaneous magnetization, Heisenberg model, Exchange interaction, ferromagnetic domains- Magnetic bubbles, Bloch wall, Thickness and energy, ferromagnetic spin waves, Magnons- Dispersion relations.

Anti-ferromagnetism: Introduction, Two sub lattice model of anti, ferromagnetism, ferrimagnetism, ferrites, structure, Applications, Multi ferroics. (Wahab P. 502-532, Kittel P.321-355, Saxena Gupta P.355-404)

Unit IV: Semiconducting and Superconducting Properties. (15)
Semiconductors: Energy band gap, effective mass intrinsic carrier concentration, conductivity of semiconductors, impurity levels in doped semiconductors, superconductors: Critical temperature, Meissner effect, type-I, type-II superconductors, BCS Theory of superconductivity, flux quantization, Josephson effect, SQUID, high- Tc super conductivity. (Wahab P. 534-558, Kittel P. 257 – 292, Saxena Gupta P.405-437)

Reference Books:-

1. Introduction to solid state physics by Puri and Babbar S. Chand publication
2. Introduction to solid state physics, Charles Kittel VIII edition, John Wiley & sons.
3. Solid state physics, A.J. Dekker, Mc Millan Publications .
4. Material Science and engineering, V. Raghavan, PHI, New Delhi.
5. Crystal Growth, B.R. Pamplin, pergmon press.
6. Crystal Growth from high temperature solutions D.Elwell and H.J Scheel, Academic press.
7. Solid state physics, M.A.Wahab, 2nd Edition Narosa Publishing House.
8. Fundamentals of solid state physics, Saxena Gupta, Pragathi Publications, meerut,
9. Solid state physics, R.L. Singhal, kedar Nath Ram Nath & Co.Pub.

Learning outcomes : Unit – I :

1. Student should able to understand concept of Crystal growth.
2. Student should able to understand melt growth, Bridgman, Czochralski techniques.
3. Students should able to imperfections- point defects and dislocations
4. Student should able to understand Experimental determination of point defects and dislocations

Unit – II :

1. Understanding of electronic , ionic and orientation polarization
2. Student should able to understand Langevin's theory and measurement of dielectric constant.
3. Student should able to understand Piezo, pyro- and ferroelectric crystals.
4. Understanding of oxygen ion displacement theory

Unit – III:

1. Student should able to understand Weiss molecular field theory of Ferromagnetism
2. Understanding of Temperature dependence of spontaneous magnetization
3. Student should able to understand two sub lattice model of anti- ferromagnetism.
4. Student should able to understand ferrimagnetisms and ferrites.

Unit – IV:

1. Student should able to define energy band gap in semiconductor.
2. Understanding of impurity levels in doped semiconductors.
3. Student should able to understand superconductors: Critical temperature, Meissner effect.
4. Student should able to understand BCS Theory of superconductivity.

M. Sc. – I Semester – I Practical **(MPT 105)**

1. Counting Statistics, G. M. Tube.
2. Double Pendulum Experiment.
3. ‘e’ by Millikan’s Oil Drop experiment.
4. Photo catalytic dye degradation of given sample.
5. Dissociation energy of Iodine molecules.
6. Magnetic susceptibility of ferric nitrate solution.
7. Four probe method.

8. TEP measurement.
9. Crystallite size and inter planner spacing calculation using given XRD data.
10. Planck's constant.

Learning outcomes:

1. Student should able to measure counts of radioactive radiations.
2. Understanding of working of Double Pendulum.
3. Student should able to measure charge of an electron.
4. Student should able to understanding of Photo catalytic dye degradation of sample.
5. Student should able to measure dissociation energy.
6. Student should able to measure Magnetic susceptibility of given solution.
7. Student should able to measure of conductivity of sample.
8. Student should able to measure thermoelectric power of sample
7. Determination of Crystallite size and inter planner spacing using XRD.
8. Student should able to determine Planck's constant.

Semester – II Practical **(MPT 205)**

1. Study of hyperfine structure of spectral lines and Zeeman effect.
2. Solar cell.
3. Specific capacitance calculation of given semiconducting material.
4. LDR (Light Dependant Register).
5. ESR (Electron Spin Resonance).
6. Ionic conductivity of sodium chloride.
7. Band gap of semiconductors.
8. Fourier analysis.
9. Rydberg constant using spectrometer.
10. Fabry-Perot Etalon.

Learning outcomes:

1. Understanding of Zeeman effect.
2. Understanding working of Solar cell.
3. Student should able to measure Specific capacitance of given semiconducting material.
4. Student should able to understanding of dependence of resistance on light.
5. Student should able to understand electron Spin Resonance.
6. Student should able to measure ionic conductivity of given solution.
7. Student should able to understanding concept of band gap.
8. Student should able to know Fourier analysis of various waves
9. Student should able to determine Rydberg constant.
10. Student should able to understand concept of Fabry-Perot Etalon.