List of Revised Courses

Department : *Pure and Applied Physics*

Program Name : *M.Sc. (Physics)*

Academic Year : 2016-17

List of Revised Courses

Sr. No.	Course Code	Name of the Course
01.	PT-101	Mathematical Physics
02.	PT-103	Quantum Mechanics-I
03.	PT-201	Atomic and Molecular Physics
04.	PT-303	Electrodynamics
05.	PT-304	Material Science-I
06.	PT-402	Accelerator Physics
07.	PT-403	Molecular Physics and Group Theory
08.	PT-404	Materials Science-II

Minutes of Meetings (MoM) of Board of Studies (BoS)

Academic Year : 2016-17

School : *School of Physical Sciences*

Department : *Pure and Applied Physics*

Date and Time : *December 12, 2016 – 11:30 AM*

Venue : *Smart Class Room*

The scheduled meeting of member of Board of Studies (BoS) of Department of Pure and Applied Physics, School of Studies of Physical Sciences, Guru Ghasidas Vishwavidyalaya, Bilaspur, was held to design and discuss the M. Sc. (Physics), scheme and syllabi.

The following members were present in the meeting:

1. Dr. R. P. Prajapati
2. Dr. M. N. Tripathi
3. Dr. R. K. Pandey
4. Dr. Parijat Thakur
5. Dr. H. S. Tewari
6. Prof. D. P. Ojha
7. Prof. P. K. Bajpai

The committee discussed and approved the scheme and syllabi. The following courses were revised in the M. Sc. (Physics):

- Mathematical Physics (PT-101)
- Quantum Mechanics-I (PT-103)
- Atomic and Molecular Physics (PT-201)
- Electrodynamics (PT-303)
- Materials Science-I (PT-304)
- Materials Science-II (PT=404)

The following new courses were introduced in the M. Sc. (Physics):

- Nuclear and Particle Physics
- Solid State Physics
- Statistical Mechanics
- Introduction to Computational Physics
- Electrodynamics
- Experimental Techniques in Physics
- Accelerator Physics
- Molecular Physics and Group Theory

Signature & Seal of HoD

Scheme and Syllabus

Course Structure
M.Sc. Physics Syllabus 2016-17

Semester-I	Semester-II
PT-101-Mathematical Physics **PT-102-**Classical Mechanics **PT-103-**Quantum Mechanics-I **PT-104-**Basic Electronic Devices **PT-105-** Lab Course	**PT-201-**Atomic and Molecular Physics **PT-202-** Nuclear and Particle Physics **PT-203-** Solid State Physics **PT-204-** Quantum Mechanics-II **PT-205-** Lab Course
Semester-III	**Semester-IV**
PT-301- Statistical Mechanics **PT-302-**Introductional to Computational Physics **PT-303-** Electrodynamics **PT-304-Specilization** (i) Material Science –I **PT-305-** Lab Course	**PT-401-**Experimental Technique in Physics **PT-402-** Accelerator Physics **PT-403-**Molecular Physics and Group Theory **PT-404- Specialization** (i) Material Science –II **PT-405-** Project Work

w.e.f. 2016-17

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FIRST SEMESTER

PT-101: MATHEMATICAL PHYSICS

Objective: The objective of this course is to provide a guide in the basic, fundamental notions of Mathematical Physics.

Unit I: Vector algebra and vector calculus, linear independence, basis expansion, Schmidt orthogonalisation. Matrices: Representation of linear transformations and change of base; Eigen values and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors, Concepts of tensors

UNIT II: Complex variables Recapitulation: Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable: single and multiple-valued function, limit and continuity; Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals,Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Series - Taylor and Laurent expansion; Branch point and branch cut; Residue theorem and evaluation of some typical real integrals using this theorem.

UNIT III: Theory of second order linear homogeneous differential equations, Frobenius method; Linear independence of solutions: Wronskian, second solution. Hermitian operators; Completeness. Special functions: Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions, generating function

UNIT IV: Integral transforms, Fourier and Laplace transforms and their inverse transforms, Bromwich integral Transform of derivative and integral of a function; Solution of differential equations using integral transforms, Delta function.

Outcomes

- Comfort with expressing systems using vectorquantities
- Manipulating vectors as "atomic" entities withoutrecourse to underlying coordinates

References:

1. Mathematical methods for physics, by G ARFEKEN
2. Mathematical method for physicists and engineers by K F REILYU, M P HOBSON and S J BENCE
3. Advanced engineering mathematics, by E KREYSZIG

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PT-103

Quantum Mechanics-I

Objective: To explore the nature of microscopic world in substantial depth in terms of meaning and interpretation so that to acquaint the learner's to initiate thinking and analyzing the physically observable phenomena.

Unit-I: Time independent and time dependent Schrodinger equations, Admissible wave function, Ehrenfest theorem, continuity equation, normalization of wave function, stationary states, applications of Schrodinger equation in bound state problems; one dimensional step, well and barrier potential, harmonic oscillator, quantum mechanical tunneling.

Unit-II: General formalism of quantum mechanics, linear vector space, operators in linear space, Eigen values and Eigen vectors of operators, projection operators, Hilbert space, quantum dynamics (Schrodinger, Heisenberg and interaction picture) , coordinate, momentum and energy representation, Dirac notations.

Unit-III: Theory of angular momentum: Angular momentum operator, orbital angular momentum, spin angular momentum, commutation relations, Eigen values and eigen vectors for L^2, L_z, addition of angular momentum, Clebish-Gordan coefficients, properties of CG coefficients (Orthogonality), Angular momentum and rotation, Wigner-Eckart theorem.

Unit-IV: Wave equation in 3-D and stationary perturbation: Motion of free particle in spherical coordinate, Hamiltonian for a free particle in spherical coordinates, bound states of an attractive Coulomb potential, Hydrogen atom, properties of hydrogen wave functions, stationary perturbation theory, first order correction, second order corrections, applications to anharmonic perturbations of the form x^3 and x^4, ground state energy of He-type atoms, linear Stark effect and Zeeman effect in hydrogen atom.

Outcome: The basic concepts of quantum mechanics including the solution of wave equation, interpretation of dynamic variable and applying wave mechanics to various situations in terms of boundary value problems.

References:

1. Quantum Mechanics by L I Schiff.
2. Quantum Mechanics by A P Messiah.

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PT201

Common Paper-I: ATOMIC AND MOLECULAR PHYSICS

Objective: Understanding the classical and quantum mechanical description of the atomic structure and related phenomena.

Unit-I: Quantum States hydrogen like atoms; Elementary idea of Atomic Orbitals; Angular and radial distribution functions; Parity of the wave function; Interaction of an atom with electromagnetic wave; Selection rules. Atomic spectra of hydrogen like atoms; Hydrogen fine structure. Space quantization.

Unit-II: Fine structures in alkali atoms; Electron spin, Vector atom model, Spin-orbit interaction; Equivalent and non-equivalent electrons, Pauli's exclusion principle, LS and JJ-Coupling, Breit's scheme, Spectra of alkaline earth elements; Normal and Anomalous Zeeman effect; Paschen-back effect; Stark effect. Hyperfine interaction and isotope shift; Hyperfine splitting of spectral lines; selection rules; Line broadening; Factors influencing linewidth.

Unit-III: Concept of Molecular Orbital's, Types of molecular energy states and molecular spectra, Electronic configuration of Diatomic molecules: H_2, O_2, NO and CN; Rotational spectra of diatomic molecule: Rigid and non-rigid rotator; Effect of isotopes Rotational Raman spectra; Intensity of rotational lines.

Unit-IV: Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Molecular potential (Morse potential, etc.); Vibration-rotation spectra and transitions, Electronic transitions: Structure, Franck-Condon principle, Rotational structure of electronic transitions, Fortrat diagram, Dissociation energy of molecules, Continuous spectra, Raman and IR spectra.

Outcome: Understanding the relations and connections between vibrational spectra and symmetry of polytatomic molecules along with their electronic structure.

Reference Books:

1. Introduction to Atomic Spectra: H.E. White.
2. Atomic Physic: S. N. Ghoshal
3. Atomic and Molecular Spectra: Raj Kumar

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PT-303

Electrodynamics and Plasma Physics

Objective: This course aims to bridge the gap between the fundamental principles taught in electromagnetism and its practical application to specific fields such as materials, physics, and chemistry related to energy storage and harvesting.

Unit-I: Review of Four-vector and Lorentz transformation in four-dimensional space, electromagnetic field tensor in our dimensions and Maxwell's equations, Wave equation for vector and scalar potential and solution, retarded potential, Lineard-Weichert potential, electric and magnetic field due to uniformly moving charge and accelerated charge, linear and circular acceleration and angular distribution of power radiated, Bremsstrahlung.

Unit-II: Motion of charge particle in electromagnetic field, uniform E and B fields, nonuniform fields, diffusion across magnetic fields, time varying E and B fields, Adiabatic invariants, first, second and third adiabatic invariant.

Unit-III: Elementary concept of plasma, plasma oscillations, Debye shielding, plasma parameters, applications of plasma, derivation of moment equation from Boltzmann equation.

Unit-IV: Hydrodynamical description of plasma, fundamental equations, hydrodynamic waves, magnetosonic waves, Alfven waves, wave phenomena in magnetoplasma, polarization, phase velocity, group velocity, cut-offs, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field.

Outcome: Students will achieve the ability to use Maxwell equations in analyzing the electromagnetic field dude to time varying charge and current distribution. They will also learn to describe the nature of electromagnetic waves and its propagation through various media.

Text and Reference Books:

1. J. D. Jackson: Classical Electrodynamics
2. Griffiths: Introduction to Electrodynamics
3. F. F. Chen: Introduction to Plasma Physics and Controlled Fusion

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PT304
Special Paper : Material Science -I

Objectives: A thorough understanding of the history of materials science with basic understanding of metals, binary alloys, magnetic materials, dielectric materials and polymers.

Laws of thermodynamics, Thermodynamic functions, Concept of free energy, Stability and metastability, Relative stability of phases, Phase rule and phase diagrams, Solid solutions, Limited and unlimited solid solubility, interstitial and substitutional solid solutions, Hume Rothery rules, Uniary (single component) and Binary phase diagrams (Lead - tin and Iron-carbon phase diagram), Lever rule, Homogeneous and heterogeneous nucleation, growth and transformation kinetics, Micro-structural changes during cooling and heating.

Preparation of bulk, thin film and nano-materials: Solid state reactions method, sol-gel method, precipitation method. Nanomaterials: Bottom up method: Cluster beam evaporation, Ion beam deposition, Chemical bath deposition; Top down method:Ball Milling, Lithography. Advantages and disadvantages of various synthesis methods.

Polymers, mechanism of polymerization, Molecular weight distribution in linear polymers, condensation. polymers, size distribution in polymer molecules, Effect of polymer structure on properties conducting polymer , Introduction to liquid crystalline materials, Mechanism of liquid crystal display devices,

Introduction to Dielectric, magnetic and multiferroic materials: Dielectric materials, linear and non-linear dielectrics, Ferro-electric materials, Important characteristics and applications of ferro-electric materials, Para, ferro, anti-ferro magnetic properties of materials, hysteresis losses, hard and soft magnetic materials, Structure and properties of spinals, garnets and hexagonal ferrites, and their uses. magnetic bubbles.

Outcome: Synthesis and characteristic properties of metals, binary alloys, magnetic materials, dielectric materials and polymers.

Books Recommended :

1. Materials Science & Engineering : V. Raghavan
2. Elements of materials science & Engineering : L.H. Van
3. The Structure and properties of materials : R.M. Rose & J. Wulf

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PT-401

PT404
Special Paper : Materials Science-II

Objectives: A thorough understanding of the history of materials science with basic understanding of metals, binary alloys, magnetic materials, dielectric materials and polymers.

Elementary idea of Advanced materials: General features and classifications, Structure models for amorphous materials, Structure and properties of metallic glass and amorphous semiconductors, Quasicrystalline materials, Materials for solar cell applications, Hydride materials (Hydrogen storage materials), Materials for Sensors and transducers application,

Materials Characterization techniques: X- ray diffaction methods for materials characterisation, powder diffraction methods, Indexing of powder diffraction patterns, Determination of particle size, Increase in x-ray diffraction peaks of nanoparticles, Shift in photo luminescence peaks, Raman and FTIR spectroscopy of materials, Photoemission microscopy,

Light / Optical Microscopy: Optical microscope- Basic principles & components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Electron Microscope and its applications in materials characterisation.Principle of Scanning Electron Microscope, study of microstructure, determination of grain size etc, Advantages of Neutron diffraction.

Thermal Analysis: Thermal analysis,Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermomechanical analysis and dilatometry,

Outcome: Synthesis and characteristic properties of metals, binary alloys, magnetic materials, dielectric materials and polymers.

Book Recommended:
1. Introduction to solid state physics : C.Kittel
2. Superconductivity Today : T.V. Ramkr ishnan and C.V. R.R
3. Raghvan, V., Materials Science & Engineering, PHI (1998).

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