Metric 1.1.2 & 1.2.2

Department: Physics

1.1.2 Percentage of programmes where syllabus revision was carried out during the last five years (20)

1.2.2 Percentage of programs in which Choice Based Credit System (CBCS)/elective course system has been implemented (20)

Programme Code	Programme Name	Year of Introduction	Status of implementation of CBCS / elective course system (Yes/No)	Year of implementation of CBCS / elective course system	Year of revision (if any)	If revision has been carried out in the syllabus during last 5 years, Percentage of content added or replaced
MS0114	MSc (Physics)	2008, 2015	Yes	2018	2015, 2018	20%
MS0214	IMSc (Physics)	2008, 2015	Yes	2018	2015, 2018	20%

19/02/2020

(Signature of the HoD)

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B.I.T., Mesra, Ranchi
Department of Applied Physics

Minutes of Board of Studies (BOS) Meeting held on 16-17 APRIL, 2018

17.04.2018

A Board of Studies (BOS) Meeting was held during 16-17 April, 2018 in Seminar Hall-I R&D Building, BIT, Mesra for a thorough discussion as well as approval of CBCS Model Syllabus of IMSc. (Physics) & MSc. (Physics).

Minutes

1. CBCS Model Syllabus for MSc. & IMSc has been finalized.
2. The basic criteria of UGC have been followed in preparing the course structure of this programme.
3. The Exit option with B.Sc. (Physics Honours) can be offered to the student who wants to opt it after successful completion of 6th semester.
4. For the purpose of Award of Honours degree the basis would be Physics papers exclusively. The total credit for B. Sc. (Physics Honours) would be 144.
5. Parallel entry to the programme is allowed in 7th semester in the form of M.Sc. programme.
6. The total credit for M. Sc. (2 year) under lateral entry would be 80 credit.
7. The credit after the completion of 10 semesters IMSc programme would be 224.

The following members of Board of Studies were present:

17/04/18
HOD, Ex-Officio
Chairperson

Dr. S. Konar
Member

Dr. (Mrs.) S. Keshri
Member

Dr. S. K. Sinha
Member

17/4/18
Dr. S. K. Rout
Member

Dr. Nishi Srivastava
Member

Dr. (Mrs.) Usha Jha
Member

Dr. S. K. Ghorai
Member

Dr. R. K. Paul
Invited Member

17/04/2018
Dr. P. K. Datta
Professor, IIT Kharagpur
External Member

17/4/18
Dr. Anil Kr. Nirala
Professor, IIT, Dhanbad
External Member

19.04.18
Mr. B. Behra
Student of 10th Sem (IMSc.)
Invited Member

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3007 Advanced Electrodynamics

[3-0-0-3]

Module 1 & 2: Waveguides, Resonant Cavities, and Optical Fibers
Transmission line parameters-transmission line equations-input impedance, SWR and power-the Smith chart-some application of transmission lines. Cylindrical Cavities and Waveguides, Waveguides, TE and TM modes in a Rectangular Waveguide, Energy Flow and Attenuation in Waveguides, Perturbation of Boundary Conditions, Resonant Cavities, Power Losses in a Cavity; Q of a Cavity, Earth and Ionosphere as a Resonant Cavity: Schumann Resonances. **[10]**

Module 3: Radiating Systems, Multipole Fields and Radiation **[6]**
Fields and Radiation of a Localized Oscillating Source, Multipole Expansion for Localized Source, Spherical Wave Solutions of the Scalar Wave Equation, Multipole Expansion of the Electromagnetic Fields, Angular Distribution of Multipole Radiation

Module 4: Special Theory of Relativity **[6]**
Matrix representation of Lorentz transformations, infinitesimal generators, Thomas precession, invariance of electric charge; covariance of electrodynamics, transformation of electromagnetic fields, relativistic equation of motion for spin in uniform or slowly varying external fields

Module 5: Dynamics of Relativistic Particles and Electromagnetic Fields **[6]**
Lagrangian and Hamiltonian for a Relativistic Charged Particle in External Electromagnetic Fields
Motion in a Uniform, Static Magnetic Field, Motion in Combined, Uniform, Static Electric and Magnetic Fields, Particle Drifts in Nonuniform, Static Magnetic Fields,

Module 6: Collisions and Energy Loss **[6]**
Energy transfer in Coulomb collision between heavy incident particle and free electron; energy loss in hard and soft Collisions; Total Energy Loss Cherenkov Radiation

Module 7: Bremsstrahlung, Method of Virtual Quanta **[6]**
Radiation Emitted During Collisions, Bremsstrahlung in Coulomb Collisions, Screening Effects; Relativistic Radiative Energy Loss, Weizsacker-Williams Method of Virtual Quanta, Bremsstrahlung as the Scattering of Virtual Quanta

Textbook and References:
1. Electromagnetic Theory - Stratton
2. Electromagnetic Theory – J. A. Kong; John Wiley and Sons, 1986
3. Classical Electricity and Magnetism – Phillips and Panofsky, Addison Wesley
4. Introduction to Electrodynamics – D. J. Griffiths; John Wiley and Sons, 1986
5. Engineering Electromagnetics - William H. Hayt
6. Elements of engineering electromagnetics - Narayana Rao, PHI
7. Electromagnetic Waves and Radiating Systems – E. C. Jordan and K. G. Balmain, Prentice Hall, Inc.

COURSE INFORMATION SHEET

Course code: PH 402
Course title: Electrodynamics
Pre-requisite(s): Electricity and Magnetism
Co- requisite(s):
Credits: L: 4 T: 0 P: 0
Class schedule per week:
Class: I.M.Sc.
Semester / Level: VII / I
Branch: PHYSICS
Name of Teacher:

Code: PH 402	**Title: Electrodynamics**	**L-T-P-C [4-0-0-4]**

Course Objectives

This course enables the students:

A.	Introducing the mathematical tools used in electrodynamics.
B.	Review of electrostatics and magnetostatics in matter.
C.	Providing easy headway into the covariant formulation of Maxwell's equations.
D.	Teaching basic principles of waveguides and transmission lines.
E.	Rendering insights into fields generated by oscillating sources, and their applications.

Course Outcomes

After the completion of this course, students will be:

1.	Ability to use basic mathematical tools to solve problems in electrodynamics.
2.	Gaining proficiency in electrostatics and magnetostatics.
3.	Obtaining command on four-vector and tensor notations.
4.	Learning about TM, TE and TEM modes in waveguides.
5.	Understanding radiations by moving charges.

Module-1	The concept of a scalar potential. Poisson's and Laplace's equations for scalar potential. Green's theorem, Electrostatic field energy density. Solutions of Laplace's equation in rectangular, spherical and cylindrical coordinates using the method of separation of variables, Method of images, Multipole expansion of potential due to a localized charge distribution.	**[8]**
Module-2	Electrostatics in matter; Polarization and electric displacement vector. Electric field at the boundary of an interface, Linear dielectrics. Magnetostatics, Biot-Savart Law, Ampere's Law, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Boundary conditions.	**[8]**
Module-3	Electromagnetic induction, Faraday's Law, Maxwell's equations, Maxwell's equations in matter, Conservation of charge, Poynting's theorem, Solutions of Maxwell's Equations, Covariant formulation of electrodynamics, Inhomogeneous wave equations and their solutions.	**[8]**
Module-4	Electromagnetic waves in matter, Reflection and refraction at a plane interface between dielectrics, Fresnel's equations. Phase velocity and group velocity, spreading of a pulse propagating in a dispersive medium, propagation in a conductor, skin depth. Transmission lines and wave guides; Dynamics of charged particles in static and uniform electromagnetic fields.	**[8]**
Module-	EM Field of a localized oscillating source. Fields and radiation in dipole and quadrupole	**[8]**

5	approximations. Antenna; Radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.	

References:

1. Introduction to Electrodynamics by D. J. Griffiths
2. Classical Electrodynamics by J. D. Jackson
3. Lectures on Electromagnetism by A. Das

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Assessment Compoents	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem Examination Marks					
End Sem Examination Marks					
Quiz I					
Quiz II					

Mapping between Course Objectives and Course Outcomes

Course Objectives	**1**	**2**	**3**	**4**	**5**
A	H	M	-	M	L
B	H	H	-	L	-
C	H	M	H	H	M
D	H	L	-	H	L
E	H	L	M	M	H

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**					
	a	**b**	**c**	**d**	**e**	**f**
1	**H**	**H**	**H**	**H**	**H**	**H**
2	**H**	**H**	**H**	**H**	**H**	**H**
3	**H**	**H**	**H**	**H**	**H**	**H**
4	**H**	**H**	**H**	**H**	**H**	**H**
5	**H**	**H**	**H**	**H**	**H**	**H**

Lecture wise Lesson planning Details.

IMSc Physics -II Semester

IMP 2101 Physics II (Electricity and Magnetism)

[3-0-0-3]

Electrostatics: Coulomb's law, Gauss's Law (integral and differential forms), electric field and potential and, electrostatic energy density, Capacitors and guard ring, lightning conductor, gold leaf electroscope, Attracted disc electrometer, Van de Graff generator, electrostatic lens for focusing of electron beams. **[5]**

Magnetism: Biot-Savart law, Gauss's Law (integral and differential forms), Lorentz force, Hall effect, magnetometers, dip circle, earth inductor, dia para ferro magnetism, magnetic properties of earth. **[5]**

Thermoelectricity and Chemical effect: Seebeck, Peltier and Thomson effect, thermopile, bolometer, Primary and secondary cells, standard cell, electroplating, lead-acid accumulator. **[4]**

Electrical Measurements: Dead beat galvanometer, ballistic galvanometer, tangent and moving coil galvanometer, wattmeter, energy meter, hot wire instruments, Shunts. **[4]**

Direct current: Ampere's circuital law (integral and differential forms), Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Maxwell's current loop method, dc bridges. **[5]**

Electromagnetism: Faraday's law of electromagnetic induction (integral and differential forms), Lenz's law, Inductance, Self and mutual induction, Ruhmkorff's coil, magnetic energy density, continuity equation for charge, displacement current, Maxwell's field equations in free space. Growth and decay of current in LR, CR, LCR circuits, analogy with spring mass system, free, damped and forced oscillations, High-Q systems. **[10]**

Alternating currents: Passage of ac through LR, CR, LCR series and parallel, power in ac circuits, power factor, wattless current, phasors, electrical machines, choke, non-inductive coil, transformer and losses, Eddy currents, hysteresis, ac / dc – motor starter, generator, ac transmission, ac bridges. **[7]**

Textbook:

1. Edward M. Purcell, David J. Morin, Electricity and Magnetism, Cambridge University Press

References:

1. David J. Griffiths, Introduction to Electrodynamics (3rd Edition), Prentice Hall Inc.
2. Halliday, Resnick and Walker, Fundamentals of Physics, Vol.-2, Wiley India Pvt. Ltd.
3. Reitz, John R.; Milford, Frederick J.; Christy, Robert W. (2008), Foundations of Electromagnetic Theory (4th ed.), Addison Wesley
4. Sadiku, Matthew N. O., Elements of Electromagnetics (4th ed.). Oxford University Press

New Syllabus

COURSE INFORMATION SHEET

Course code: PH 102
Course title: ELECTRICITY AND MAGNETISM
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Class schedule per week:
Class: I.M.Sc.
Semester / Level: I
Branch: PHYSICS
Name of Teacher: Dr R. Kumar

Theory: 50 Lectures

Code: PH 102	**Title: ELECTRICITY AND MAGNETISM**	**L-T-P-C [3-1-0-4]**

Course Objectives : This course enables the students to

1	know and apply the basic theorems related to electrostatics potential and field
2	know how to deal electrostatics situation when dielectric is involved.
3	know the various laws of magnetostatics in vacuum and when there is magnetic medium
4	know the laws of electrodynamics and its application in AC circuits.
5	know about Network theorems in linear circuits

Course Outcomes : After the completion of this course, students will be able to

1.	apply Gauss's law and uniqueness theorem to calculate electric field
2.	to calculate various quantities like displacement vector and polarization in the presence of dielectircs.
3.	to apply the laws of magnetostatics-like Biot-Savart law, Ampere's circuital law, and to calculate the hysteresis energy loss .
4.	to apply Maxwell's equations, and the laws of electromagnetic induction to deal AC circuits.
5.	to apply network theorems to get the information about the voltage and current in various branches of a dc circuit

Module-1	**Electric Field and Electric Potential** Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.	**10**
Module-2	Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere **Dielectric Properties of Matter:** Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.	**10**
Module-3	**Magnetic Field**: Magnetic force between current elements and definition of Magnetic FieldB. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity(**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.	**10**
Module-4	**Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current . **Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series	**10**

	LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.	
Module-5	**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits **Ballistic Galvanometer:** Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CD	**10**

References:

Text books:

1. Introduction to Electrodynamics by D.J. Griffits, Prentice Hall(1999).
2. Electricity and Magnetism by E. M. Purcell and D. J. Morin, Cambridge. University press(2013)
3. Schaum's outline of Theory and Problems of Electrical Circuits, TMH 2002, by Mahmood Nahri & J. Edminister

Reference books:

1. Classical electrodynamics, J.D. Jackson, John and Wiley press, Third edition

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End SemExamination Marks	60
Assignment / Quiz (s)	15

AssessmentCompoents	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks	Yes				
End Sem Examination Marks	Yes				
Assignment	Yes				

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes					
	a	b	c	d	e	f
1	H	H	H	M	M	H
2	H	H	H	L	L	M
3	H	H	H	M	M	M
4	H	H	H	M	M	M
5	H	H	H	M	M	M

Mapping of Course Outcomes onto Course Objective

Course Objective#	Course Outcomes

IMSc Physics I Semester

IMP 1001 Physics-I General Properties of Matter, Waves & Oscillations

[3-1-0-4]

Module I: Systems of particles**:** Centre of mass, Linear momentum, Conservation of linear momentum, System with varying mass: A Rocket; Work and Kinetic Energy Theorem, Potential energy and conservation of energy, Conservative and non-conservative forces, Force as gradient of potential energy; Particle collisions: Elastic and inelastic collision, Centre of Mass and Laboratory Frames. **[8]**

Module II: Angular momentum of a particle and system of particles, Angular momentum of rigid body rotating about a fixed axis, Conservation of angular momentum, Torque, Rotation about a fixed axis. Moment of inertia and its calculation for bar, circular disc and solid cylinder. **[6]**

Module III: The world and gravitational force, Newton's law of gravitation, Gravitation near earth's surface, Gravitation inside earth, Gravitational potential energy, Escape speed, Planets and satellites: Kepler's Laws. **[6]**

Module IV: Hooke's Law, Young's Modulus, Bulk Modulus, Shear Modulus, Elastic energy in different types of deformation, Torsion of a cylinder, Strain Energy in a twisted cylinder, Bending moment, Cantilever, Beam supported at both ends, Beams clamped at both ends. **[6]**

Module V: Molecular forces, Surface tension and surface energy, Angle of contact, Excess pressure over a curved liquid surface (drops and bubbles), Capillarity, Viscosity and Coefficient of viscosity, Laminar flow, Streamline and turbulent motion, Reynold's number; Poiseuille's equation, Stokes' law, Rotating cylinder and rotating disc methods for determining the coefficient of viscosity, Energy of the fluid, Euler's equation for liquid flow; Bernoulli's theorem and its applications. **[8]**

Module VI: Simple harmonic motion, Motion of simple and compound pendulum. Damping, Forced vibration and resonance, Wave equation in one dimension, Phase velocity, Group velocity, Dispersion. **[8]**

Module VII: Types of wave, transverse and longitudinal waves. Speed of a travelling waves, Wave speed on a stretched string, Energy and power of a travelling string wave, principle of superposition for waves, Interference of waves, Stationary waves, Sound waves, speed of sound Intensity of sound. Measurement of intensity; beats and applications, the Doppler effect, Shock waves. **[8]**

Textbooks:

1. Mechanics by R.K. Shukla. and A. Srivastava New Age International
2. Elements of Properties of Matter: by D. S. Mathur, Publisher: S Chand & Co.

Reference Books:

1. Sears and Zemansky's University Physics by H.D.Young, R.A.Freedman, A.L.Ford, Publisher: Pearson
2. Fundamental of Physics, by Halliday D., Resnick R. and Walker J., Publisher: Wiley India
3. Mechanics by D.S.Mathur and P. S. Hemne, Publisher: S Chand & Co.
4. Waves and Oscillations by A. P. French, Publisher: CBS Publishers & Distributors

CORE COURSE (I.M.Sc. 1st to 6th Semesters)

Semester I

COURSE INFORMATION SHEET

Course code: PH 101
Course title: Mechanics
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Class schedule per week:
Class: I.M.Sc.
Semester / Level: I
Branch: PHYSICS
Name of Teacher: Dr. S. Lahiri

Theory: 50 Lectures

Code: PH 101	**Title : Mechanics**	**L-T-P-C [3-1-0-4]**
Course Objective: 1. A gentle introduction to the kinematics of rigid bodies and the concepts of work and energy. 2. Advancing the above notions to explain collision processes, and teaching rotational dynamics. 3. Exemplification of the notion of central force motion through discussions on gravitation. 4. Providing familiarity with the mathematical structure of waves and oscillations. 5. Introduction to the niceties of the special theory of relativity. 6. Discussion of some preliminary ideas of fluid motion and elasticity. **Course Outcome:** **1**. Ability to solve problems on mechanics using the notion of work and energy. 2. Developing intuitive as well as mathematical understanding of rotational dynamics. 3. Getting equipped with mathematical tools to handle problems on central force motion. 4. Capacity to grasp the underlying principles of waves and oscillations. 5. Solving problems related to relativistic transformation of variables in different inertial frames. 6. Ability to explain common effects of fluid motion and elasticity.		
Module-1	**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy	**10**
Module-2	**Collisions:** Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. **Rotational Dynamics**: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation **Fluid Motion:** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **Elasticity:** Relation between Elastic constants. Twisting torque on a Cylinder or Wire.	**10**
Module-3	**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws.	**12**

	Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.	
Module-4	**Non-Inertial Systems:** Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.	**8**
Module-5	**Special Theory of Relativity:** Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.	**10**

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
5. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

Additional Books for Reference

1. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
2. University Physics, F.W.Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
3. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Gaps in the syllabus (to meet Industry/Profession requirements) :
POs met through Gaps in the Syllabus :
Topics beyond syllabus/Advanced topics/Design :
POs met through Topics beyond syllabus/Advanced topics/Design :

Assessment Compoents	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem Examination Marks					
End Sem Examination Marks					
Quiz I					
Quiz II					

Mapping between Course Objectives and Course Outcomes

Course Objectives	**1**	**2**	**3**	**4**	**5**
A	H	L	L	L	M
B	M	H	-	-	-
C	L	-	H	-	-
D	-	-	-	H	-

IMSc Physics -IV Semester

IMP 4101 Physics IV - Optics

[3-0-0-3]

Modules I & II: Geometrical Optics:
Introduction to geometrical and physical optics, Fermat's principle of least action, reflection, refraction, refraction through spherical surfaces, conjugate foci for refraction at a spherical surface, transverse and longitudinal magnification of image formed by a spherically refracting surface, Lagrange and Helmholtz Laws of magnification, refraction through convex lens, deviation produced by a thin lens, introductory idea of thick lens. cardinal points, lenses separated by a finite distance and equivalent focal length, graphical construction of images using cardinal points, optic centre of a lens. **[10]**

Module III: Aberrations
Spherical aberrations, minimizing spherical aberration, chromatic aberration, condition for achromatism, coma, astigmatism, curvature of the field, Huygen's and Ramsden's eye pieces. **[4]**

Module IV & V Interference
Conditions for sustained interference, theory of interference, Two-Beam Interference, Interference in parallel and wedge shaped films, Achromatic fringes, Color of thin films. Newton's rings and Michelson interferometer and their applications. Multiple beam interference in parallel film and Fabry-Perot interferometer, limit of resolution. **[10]**

Module VI: Diffraction
Fresnel's diffraction, Zone plate, diffraction due to straight edge. Fraunhofer diffraction due to single (rectangular and circular) and double slits, plane transmission grating and its resolving power. **[6]**

Module VII: Polarization
Polarization of light, Malus law, polarization by reflection, Brewster's law, Analysis of linearly and circularly polarized light, Polarization by double refraction and Huygen's theory, Nicol prism, Retardation plates, Optical activity and Fresnel's theory, Biquartz polarimeter. **[10]**

Textbooks:
1. Fundamentals of Optics - Jenkins and White; McGraw-Hill
2. Optics - A. Ghatak; Tata McGraw-Hill Education

Reference books:
1. Optics - Hecht and Zajak; Addison-Wesley Pub. Co.

COURSE INFORMATION SHEET

Course code: PH 106
Course title: WAVES AND OPTICS
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 4 L:3 T: 1 P: 0
Class schedule per week: 3
Class: I.M.Sc.
Semester / Level: II
Branch: PHYSICS
Name of Teacher:Dr Nishi Srivastava

Theory: 50 Lectures

Code: PH 106	**Title: WAVES AND OPTICS**	**L-T-P-C [3-1-0-4]**

Course Objectives: This course enables the students

A.	To provide thorough knowledge of superposition principle, superposition of collinear and perpendicular oscillations; and basic information about waves
B.	To appreciate the variation in velocity of waves and formation of standing waves.
C.	To understand the concept of interference and instruments based on this phenomenon.
D.	To know the concept of diffraction, its theory and classes
E.	To understand the polarized light and its basic principles.

Course Outcomes: After the completion of this course, students will

A.	Be able to explain superposition principle, formation of Lissajous figure and classes of waves
B.	Be able to understand changes in waves and characteristics of standing waves
C.	Be able to explain the optical phenomenon interference and working of instruments based on this phenomenon
D.	Get familiar with optical phenomenon diffraction and various theory explaining it
E.	Acquire knowledge of polarization, various class of polarized light and its construction

Module-1	**Superposition of Collinear Harmonic oscillations**: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **Superposition of two perpendicular Harmonic Oscillations**: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **Wave Motion:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.	12
Module-2	**Velocity of Waves:** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **Superposition of Two Harmonic Waves**: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes.Superposition of N Harmonic Waves. **Wave Optics:** Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.	12
Module-3	**Interference:** Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index **Interferometer**: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.	12
Module-4	**Diffraction:** Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) **Fraunhofer diffraction:** Single slit. Circular aperture, Resolving Power of a telescope. Double slit.	10

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Minutes of the Board of Studies Meeting held on 28/09/2015

The Board of Studies (BOS) meeting of the department of physics has been held on 28/09/2015 to discuss and finalize the Course Structures and syllabi of 5-year Int.M.Sc in Physics and M.Sc in Physics. The members of the BOS have held detailed discussion on the Course Structures and syllabi of Int.M.Sc(Physics) and M.Sc (Physics) which have been recommended by the faculty members of the department of Physics. After detailed discussion, the BOS has recommended following course structures and syllabi, details of which are attached herein.

Following Board of Studies Members attended the meeting

H.O.D Physics
(Chairman)

28/9/'15
Prof. A.K.Nirala
(External Member)
(Prof. & Head, Department of Applied Physics,
ISM, Dhanbad)

Prof.S.K.Ghorai
(Member)

Prof. S.Konar
(Member)

Prof. S.Keshri
(Member)

Dr.S.K.Sinha
(Member)

Dr.S.K.Rout
(Member)

Dr.Nishi Srivastava
(Member)

IMP 9015 Non-conventional Energy Resources (3-0-0-3)

Module I: Conventional Energy Sources: World's reserve of commercial energy sources and their availability – various forms of energy – renewable and conventional energy systems – comparison – coal, oil and natural gas – availability – statistical details – applications – merits and demerits. [5]

Module II: Non-Conventional Energy Sources: Renewable energy sources – solar energy – nature of solar radiation – components – solar heaters – crop dryers – space cooling – solar ponds, solar cookers – water desalination – photovoltaic generation basics – merits and demerits of solar energy. [5]

Module III: Direct Energy Conversion: Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermo-electric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions. [5]

Module – IV: Principles Of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, Solar radiation on tilted surface, Instruments for measuring solar radiation and sun shine, solar radiation data. [5]

Module – V: Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/ cooling techniques, solar distillation and drying, Solar Photovoltaic systems-fundamentals, characteristics, classification, solar cell modue, panel, array construction, maximum PV O/P and load matching, power point tracker, balance and applications. [5]

Module – VI:

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

Bio-Mass: Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation, and economic aspects. [5]

Module – VII:

Geothermal Energy: Resources, types of wells, methods of harnessing the energy potential in India.

Ocean Energy And Hydro Resources: Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave energy: Potential and conversion techniques, mini-hydel power plants, their economics, Micro-Hydro scheme, water turbine, classifications, characteristics, selection, generators, present status, fuel cell, hydrogen energy, PEM fuel cell. **[5]**

References:

1. Renewable Energy Resources / Tiwari and Ghosal / Narosa
2. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.
3. Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd.
4. Non-conventional energy resources, B. H. Khan, McGraw Hill.

SAP 4013 Nonconventional Energy Materials

[3-1-0-4]

Module 1: Current Status of Energy Sources: Energy sources and their availability, conventional sources of energy: Fossil fuel, Hydraulic energy, Nuclear energy: nuclear fission, nuclear fusion, Environmental impact of conventional sources of energy, Need for sustainable energy sources, Non-conventional energy sources, Current status of renewable energy sources. **[6]**

Module 2: P-N Junction Solar Cells: P-N Junction: space charge region, energy band diagram, carrier movements and current densities, carrier concentration profile; P-N junction in non-equilibrium condition, I-V Relation, P-N Junction under Illumination, Generation of photovoltage, Light generated current, I-V equation of solar cells. **[6]**

Module 3: Design of Solar Cells and its characterization : Solar Cell Characteristics and Cell parameters: Short circuit current, open circuit voltage, fill factor, efficiency; losses in solar cells, Solar Cell Design: design for high I_{sc}, design for high V_{oc}, design for high FF; Solar spectrum at the Earth's surface, Solar simulator: I-V Measurement, quantum efficiency (QE) Measurement, minority carrier lifetime and diffusion length measurement. **[7]**

Module 4: Wafer-Based Solar Cell Technology: Development of Si solar cells, Processes of solar cell fabrication: saw damage removal and surface texturing, P-N Junction formation, ARC and surface passivation, metal contacts—pattern defining and deposition. Thin Film Solar Cell Technologies: Advantages of thin film technologies, materials for thin film technologies, thin film deposition techniques, thin films solar cell structures, thin film crystalline, microcrystalline, polycrystalline, and amorphous Si solar cells. **[10]**

Module 5: Emerging Solar Cell Technologies
Organic Solar Cells: working principle, material properties, solar cell structure; Dye-sensitized Solar Cell (DSC): working principle, materials and their Properties; GaAs solar cells, Thermo-photovoltaics, multijunction solar cells. **[7]**

Module 6: Nonconventional Energy Sources: Wind Energy: Classification of wind mills, advantages and disadvantage of wind energy; Bio Energy: Bio gas and its compositions, process of bio gas, generation – wet process, dry process, utilization and benefits of biogas technology. **[7]**

Module 7: Other Nonconventional Energy Sources: Tidal Power: Introduction, classification of tidal power plants, factors affecting the suitability of the site for tidal power plant, advantages and disadvantages of tidal power plants. Fuel Cells: Introduction, working of fuel cell, types of fuel cells, advantages of fuel cell technology. Solar Thermal: Solar collectors, solar cookers, solar water heater. **[7]**

Text/Reference Books:

1. Solar cells: Operating principles, technology and system applications by Martin A Green, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Semiconductor for solar cells, H J Moller, Artech House Inc, MA, USA, 1993.
3. Solis state electronic device, Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.
4. Direct energy conversion, M.A. Kettani, Addision Wesley Reading, 1970.
5. Hand book of Batteries and fuel cells, Linden, Mc Graw Hill, 1984.

Electives

SAP 3107 Nonlinear Optics (3-0-0-3)

1. **Origin of Nonlinear Optical Phenomena:** Introduction to nonlinear optics, description of nonlinear optical interaction, phenomenological theory of nonlinearity, nonlinear optical susceptibilities, second and third order optical susceptibilities. [5]

2. **Second harmonic Generation:**Sum and difference frequency generation, second harmonic generation (SHG), phase matching of SHG, quasi phase matching, electric field induced SHG (ElFISH), optical parametric amplification. **[5]**

3. **Two level atoms:** Nonlinear Optics in two level approximations, Density matrix equation, closed and open two level atoms, steady state response in monochromatic field, Rabi oscillations, dressed atomic state, optical wave mixing in two level systems. **[5]**

4. **Optical phase conjugation**: Principle, Aberration correction by OPC, Application of OPC in signal processing. [5]

5. **Intensity dependent phenomena:** Intensity dependent refractive index, self focusing, self phase modulation and spectral broadening, optical continuum generation by short optical pulse. Self induced transparency. Spatial and temporal solitons, solitons in Kerr media. Pulse compression. Applications. **[5]**

6. **Bistability:** Optical bistability, Steady state bistability, absorptive bistability, Dispersive bistability, Optical switching. **[5]**

7. **Ultra fast Phenomena:**
   Ultra fast pulse generation with and without mode locking, Generation of femto second pulses, Coherent transients, Optical Nutation, Free induction decay, photon echo. **[5]**

Textbook:

1. Nonlinear Optics: Robert Boyd, Academic Press

References:

1. Nonlinear Optics in signal processing: W.Easan and A.Miller, Chapman and Hall
2. Physics of Nonlinar Optics: Guang- Sheng -He and Song-Hao Lin, World Scientific
3. Flytzanis and L.Oudar; Nonlinear Optics: Device and Applications, Springer Verlag, (1986)

SAP 4027 Quantum and Nonlinear Optics

[3-1-0-4]

Module I & II: Nonlinear Optical Phenomena: Introduction to nonlinear optics, description of nonlinear optical interaction, phenomenological theory of nonlinearity, nonlinear optical susceptibilities. Sum and difference frequency generation, second harmonic generation, coupled wave equation. Manley-Rowe relations, phase matching of SHG, quasi phasematching, electric field induced SHG (EIFISH), optical parametric amplification, third harmonic generation, two-photon absorption. Stimulated Raman scattering and stimulated Brillouin scattering. **[12]**

Module III: Two level atoms: nonlinear optics in two level approximations, density matrix equation, closed and open two level atoms, steady state response in monochromatic field, Rabi oscillations, dressed atomic state, optical wave mixing in two level systems. **[10]**

Module IV: Intensity dependent phenomena: intensity dependent refractive index, self-focusing, self phase modulation,spectral broadening, optical continuum generation by short optical pulse. Optical phase conjugation, application of OPC in signal processing. Self induced transparency, spatial and temporal solitons, solitons in Kerr media, photorefractive and quadratic solitons, optical vortices. Pulse compression. **[10]**

Module V: Bistability: optical bistability, Steady state bistability, absoptive bistability, Dispersive bistability, Optical switching. **[6]**

Module VI: Ultra fast Phenomena: ultrafast pulse generation with and without mode locking, range gating with Ultra short pulse, four dimensional imaging. femto second laser Gyroscope, Soliton pulses. Transient NLO effects, Bloch vectors, Rabi oscillations, photon echo, self induced transparency, optical nutation, free induction decay. [6]

Module VII: Nonlinear guided wave optical devices: nonlinear planar waveguide, nonlinear channel waveguide, nonlinear directional coupler, nonlinear mode sorter, nonlinear Mach-Zehnder interferometer and logic gate, Nonlinear loop mirror. [6]

Book:

1. Fundamentals of Nonlinear Optics; P.E.Powers, CRC Press Francis and Taylor (2011)
2. Principles of Nonlinear Optics; Y.R.Shen
3. Nonlinear Optics: Robert Boyd, Academic press
4. Physics of Nonlinar Optics: Guang- Sheng –He and Song-Hao Lin; World scientific.
5. Two Level Resonances in Atoms; Allen and J.H. Emberly, John Wiley.

Semester IX

SAP 3201 Nuclear Physics and Engineering (3-0-0-3)

1. **Nuclear Models**
   Liquid drop model, semi-empirical mass formula, transitions between odd A isobars, transitions between even A isobars, odd-even effects & magic numbers, shell model

2. **Two nucleon problem**
   Ground state of deuteron, excited state of deuteron, nature of nuclear forces, spin-dependence of nuclear force tensor forces, meson theory of nuclear force

3. **Scattering**
   Neutron-proton scattering at low energies, cross-section, scattering cross-section, scattering length, proton-proton scattering at low energies,

4. **Interaction of radiation with matter**
   Interaction of charged particles with matter, stopping power of heavy charged particles, energy loss of heavy ions and electrons, Cerenkov radiation, absorption of gamma rays, photoelectric effect, Compton effect and pair production

5. **Accelerators & Detectors**
   Electron source, ion source, linear accelerator, synchrotron, introduction to advance accelerator (LHC)
   Ionization chamber, scintillation counter, semiconductor counter, Cerenkov detectors

6. **Elementary particles**
   Classification of elementary particles, particles and anti particles, fundamental interactions (response of particles to strong, electromagnetic and weak interactions), elementary particles quantum numbers, conservation laws and symmetry, the CPT theorem

Books Recommended:

1. Nuclear Theory- Roy and Nigam
2. Nuclear Physics-D C Tayal
3. Nuclear Physics : D. Halliday
4. Nuclear Physics: I. Kaplan
5. Physics of Particle Accelerators:-Kalus Wille
6. Elementary Particles: I S Hughes

I.M.Sc Physics-IX-Semester/M.Sc Physics -III Semester

SAP 3301 Nuclear and Particle Physics

[3-0-0-3]

Module I: Nuclear Models

Nuclear Models Liquid drop Model, semi-empirical mass formula, transitions between odd A isobars, transitions between even A isobars, odd-even effects & magic numbers, shell Model , collective model.

Module II: Two nucleon problem

The Deuteron, ground state of deuteron, nature of nuclear forces, excited state of deuteron, spin-dependence of nuclear force, meson theory of nuclear force

Module III: Scattering

Cross-section, differential cross-section, scattering cross-section, nucleon-nucleon scattering, proton-proton and neutron-neutron scattering at low energies.

Module IV: Interaction of radiation with matter

Interaction of charged particles with matter, stopping power of heavy charged particles, energy loss of electrons, absorption of gamma rays, photoelectric effect, Compton effect and pair production

Module V: Elementary particles I

Mesons, leptons, baryons, antiparticles, neutrinos, antineutrino and strange particles

Module VI: Elementary particles II

Eightfold way, Baryon octet and meson octet, Quark model, Baryon Decuplet, meson nonlet, Intermediate vector boson, strong, electromagnetic and weak interactions, standard Model, lepton classification and quark classification.

Books Recommended:

1. Nuclear Theory- Roy and Nigam
2. Introductory Nuclear Physics- Kenneth S. Krane
3. Nuclear Physics : D. Halliday
4. Elements of Nuclear Physics :Pandya and Yadav
4. Introduction to Elementary Particles: David Griffiths