Unit 5:

Lasers, spontaneous and stimulated emission of radiation, optical pumping and population inversion. Metastable states. Three level and four level lasers. Einstein's coefficients, Requisites for producing laser light, Laser rate equations, Optical resonators, He-Ne laser, Solid state laser, Gas lasers, Semiconductor lasers, Laser applications. Basic idea of MASER. **(12 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to develop a comprehensive idea of the main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter, understand the theory of quantum measurements, wave packets and Uncertainty Principle, understand the central concepts of quantum mechanics: wave functions, various operators, the Schrodinger equation, probability density and the normalization techniques etc. Students are also expected to have the basic idea of some atomic models and applications of LASERs.*

Reference Books:

i. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
ii. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
iii. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2^{nd} Edn., 2002, Wiley.
iv. Quantum Mechanics, G. Aruldhas, 2^{nd} Edn. 2002, PHI Learning of India.
v. Atomic Physics - J. B. Rajam, S. Chand & Co.
vi. Modern Physics by R. Murugesan, S. Chand & Co., Reprint, 2008.
vii. Atomic and Nuclear Physics- N. Subramaniam & Brijlal, S. Chand & Co.

PHYDSC302T

INTRODUCTION TO CLASSICAL MECHANICS AND ELECTROMAGNETIC THEORY

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *The objective of this course is to build the concepts of classical mechanics with methods of formulations of Lagrangian and Hamiltonian and their applications. The emphasis of the course is also on understanding the basic concepts of electromagnetic induction and building the required prerequisites to understand electrodynamic wave propagation.*

Unit: 1: Classical Mechanics

Dynamics of a system of particles: Centre of mass of two particle system, Velocity, acceleration and linear momentum of centre of mass of two particle system, degrees of freedom, Constraints, and their classification

Characteristics of motion under central force, Reduction of two-body central force problem to the equivalent one body problem, Central force and motion in a plane, Equations of motion and differential equation of orbit. Kepler's laws of motion and their deductions. **(12 Lectures)**

Unit 2: Lagrangian formalism

Generalized coordinates and velocities, Principle of virtual work, D'Alembert's Principle. Langrange's equations from D'Alembert's principle. Hamilton's principle, and the Lagrange's equations. Deduction of Hamilton's principle from D'Alembert's principle. Application of the Euler-Lagrange equations to one-dimensional Simple Harmonic Oscillators, simple pendulum, compound pendulum and free-falling body in uniform gravity. **(12 Lectures)**

Unit: 3: Hamiltonian Formalism

Canonical momenta & Hamiltonian. Hamilton's equations of motion, Physical significance of Hamiltonian (H). Application of Hamilton's equation for free particle, Simple Harmonic Oscillators, simple pendulum, compound pendulum, particle in a central force field, charged particle in electromagnetic field, particle moving near the surface of earth, conservation of linear momentum, angular momentum and energy. **(12 Lectures)**

Unit: 4: Electromagnetic Induction

Electric and Magnetic flux, Electro-motive force, Faraday's law of induction (differential and integral form Lenz's law and conservation of energy. Self (L) and mutual inductance (M), self-inductances in series and in parallel. L of a long solenoid, coaxial cylinders and Toroids. Mutual inductance between two coaxial solenoids, coefficient of coupling & its derivation. Energy stored in magnetic Field. Transformer, different losses of transformer. **(12 Lectures)**

Unit 5: Maxwell`s equations and Electromagnetic wave propagation

Equation of continuity of current, Displacement Current. Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Wave Equations for Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Poynting Theorem and Poynting Vector.

(12 Lectures)

Expected learning outcomes: *At the end of this course the students are expected to know the Lagrangian and the Hamiltonian formulations of classical mechanics and their applications in appropriate physical problems. Students are also expected to have the basic idea with which they can comprehend the role of Maxwell's equations in unifying electricity and magnetism.*

Reference Books:

i. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.

ii. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.

iii. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.

iv. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.

v. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.

vi. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.

vii. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.

viii. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.

ix. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press.
x. Classical Mechanics and properties of Matter, A. B. Gupta, Books and Allied publisher.
xi. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
xii. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
xiii. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning.
xiv. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning.

PHYDSC303P

LAB: RAY OPTICS AND PHYSICAL OPTICS

Contact Hours: 60

Full Marks = 100

Course objective: *In this course, the students will learn to use various instruments, estimate various physical parameters for every experiment performed and report the result of experiments related to Ray optics and Physical optics.*

Two Experiments are to be performed – one from each part

Part-A: Ray Optics

1. To determine the focal length of a given convex lens by pin method.
2. To determine the focal length of a given convex lens by displacement method.
3. To determine the focal length of convex mirror with the help of convex lens by optical bench.
4. To determine the refractive index of the given liquid with the help of plane mirror, convex lens and spherometer.
5. To determine the refractive index of a given liquid by travelling microscope.
6. To determine refractive index of the material of a prism using sodium light source.
7. To determine the angle of minimum deviation of the angle of the given prism with the help of spectrometer & hence to find the refractive index of the material of the prism.
8. To draw the calibration curve connecting refractive index & wavelength of some known lines using prism & spectrometer & hence to calculate the wavelength of an unknown line.
9. To draw the calibration curve connecting the deviation of a ray by a prism & wavelength of some known lines using spectrometer & hence to calculate the wavelength of unknown line.