**Course: M.Sc (Physics)**

| | |
|---|---|
| Semester | 2 |
| Paper Number | 6 (MPHC4202) |
| Paper Title | Classical Electrodynamics and Classical Mechanics II |
| No. of Credits | 6 |
| Course description/objective | **Group A:**<br>In this course, the students are taught the wave equation for electromagnetic waves and its solution. They are expected to learn the concept of retarded potentials leading to the Lienard-Wiechert potentials of a moving charge. They are also familiarized with the electric and magnetic fields due to a dipole. Larmor's formula is also discussed. In addition, synchrotron radiation, brehmstrahlung and Cherenkov radiation are also studied.<br>**Group B:**<br>In this course, there are two broad topics; Continuum Mechanics and Fluid Mechanics. In continuum mechanics, students are introduced to the Lagrangian formulation for continuous systems and fields. In Fluid mechanics, students are taught ideal fluids (the Euler equation) and viscous fluids (the Navier-Stokes equation). Stokes' law is derived. They are also introduced to boundary layer theory. |
| Course Outcome | **Group A**<br>CO1: After completing this course, students should be able to determine the solutions to the electromagnetic wave equation.<br>CO2: They should be able to obtain the electric and magnetic fields due to a moving charge.<br>CO3: They should also have grasped the important characteristics of synchrotron radiation and Cherenkov radiation.<br>Co4: They should also be able to obtain the power radiated by an electric dipole.<br><br>**Group B**<br><br>CO1: After completing this course, the students should be able to analyze the behavior of both ideal fluids and viscous fluids.<br>CO2: They should also have an acquaintance with boundary layers. |
| Syllabus | **Group A: Classical Electrodynamics**<br><br>Vector and scalar potentials, Gauge transformations: Lorentz and Coulomb gauge, Helmholtz theorem (with proof); Inhomogeneous wave equation; Green function for the inhomogeneous wave equation.<br><br>[8 lectures]<br><br>Simple radiating systems: Fields and radiation of a localized oscillating source, electric dipole fields and radiation, angular distribution of radiation due to an oscillating dipole. Center-fed linear antenna.<br><br>[9 lectures]<br><br>Radiation by moving charges: Lienard-Wiechert potentials and fields for a point charge, charges moving with uniform velocity, accelerated charges, radiation from accelerated charges moving (i) with low velocities and (ii) with relativistic velocities, bremsstrahlung, synchrotron radiation; Cherenkov radiation. Rayleigh's scattering and the colour of sky.<br><br>[13 lectures] |

| | |
|---|---|
| | Total power radiated by an accelerated charge – Larmor's formula, angular distribution of radiation, radiation reaction – Abraham Lorentz formula<br><br>[6 lectures]<br><br>**<u>Group B: Classical Mechanics–II (Continuum Mechanics)</u>**<br><br>Canonical formalism for continuous media: Lagrangian and Hamiltonian densities, Noether's theorem, Energy momentum Tensor; applications to sound wave equation and Maxwell equation.<br><br>[18 lectures]<br><br>Fluid Systems: Stress and Strain Tensors, Lagrangian and Eulerian coordinates, Conservation equations, The Navier-Stokes-Duhem Equations for Fluid Motion. Applications.<br><br>[18 lectures] |
| References | **<u>Group A:</u>**<br>1. Classical Electrodynamics (3rd edition, Wiley) – J.D. Jackson<br>2. Classical Electricity and Magnetism (2nd edition, Dover Publications) – Panofsky and Phillips<br>3. Introduction to Electrodynamics (4th edition, Pearson)– D. J. Griffiths<br>4. Foundations of Electromagnetic Theory (4th edition, Pearson) – Reitz, Milford and Christy<br>5. Feynman Lectures Vol. II - R. P. Feynman, R. B. Leighton and M. Sands (Addison-Wesley)<br><br>**<u>Group B:</u>**<br>1. Bachelor, An introduction to fluid Mechanics; CUP<br>2. Faber, Fluid Dynamics for Physicists; CUP<br>3. Falkovich, Fluid Mechanics, a short course for Physicists; CUP<br>4. White, Fluid Mechanics; WCB McGraw Hill<br>5. Kundu & Cohen, Fluid Mechanics, Academic Press<br>6. Classical Mechanics, Goldstein<br>7. Classical Mechanics, K. C. Gupta |
| Evaluation | Total: 100<br>CIA: 10 (Group A) + 10 (Group B)<br>End Semester Examination: 40 (Group A) + 40 (Group B) |