Master of Science in Physics
M.Sc. (Physics) Semester II

Course Code	**PS02CPHY53**	Title of the Course	**Electrodynamics**
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. This course on electromagnetic theory is one of the core courses of physics taught at the MSc level. Its basic objective is to provide an indepth training on the basic mathematical skills for quantitative analysis of electromagnetic phenomena based on basic physical quantities through the fundamental Maxwell equations, the nature of electromagnetic wave and its propagation through different media and its behaviour at interfaces of different media. 2. To provide basic training related to the propagation methods of electromagnetic waves through different types of wave guides, the design aspects of particular mode of propagation and the fundamentals of resonators. 3. The later parts of the course will provide all the mathematical details of radiation production, classification and power distribution etc. 4. To understand the mechanism of radiations due to accelerating charged particle under different geometric motions and its application for the working and to help in designing different types of antenna are the objectives of this course. 5. The course is planned to enable the students to acquire the required mathematical skills and physical interpretations of various electromagnetic phenomenon that occur in nature. 6. It will also help the students to generate and adopt new technologies based on electromagnetic fields and radiations.

Course Content		
Unit	Description	Weightage* (%)
1	Maxwell's equations in matter: Continuity equation, Poynting theorem – Momentum conservation, Maxwell's stress tensor – Angular momentum. Electromagnetic Waves in Vacuum: Wave equation for E and B fields, Monochromatic plane waves, Energy & momentum in electromagnetic waves, Polarization of electromagnetic waves: linear and circular polarization. Electromagnetic waves in matter: Propagation in linear media- Boundary conditions, Reflection and Refraction – Snell's law. Reflection and Transmission at normal and oblique incidence – Fresnel's equations.	25%
2	Total internal reflections, EM waves in isotropic linear conducting media – Reflection at conducting surface. Wave Guides and Resonant Cavities: Bounded waves – TE, TM, TEM modes, Rectangular wave guides, Circular cylindrical wave guides, Resonant cavities, Q of a cavity, Dielectric wave guides (Optical fiber), H E Modes.	25%
3	Electromagnetic Radiation: Electromagnetic potentials Scalar and vector potentials, Gauge transformations, Gauge conditions (Lorentz and Coulomb gauges). Retarded Potentials, Jefimenko's equations for the E and B fields. Radiations from extended sources: Electric dipole radiation Magnetic dipole and electric quadrupole radiations, Center-fed linear antenna, Hertzian dipole antenna, Small loop antenna.	25%
4.	Radiation from Moving point charges: Lienard-Wiechert potentials-Fields of a moving point charge, Power radiated by a point charge (Larmor formula), Radiation from a slowly moving charges, Radiation from relativistically moving charges, Larmor's generalization to relativistic case, Synchrotron radiation, Bremsstrahlung radiation. Scattering of radiation from quasi free charges (Thomson Scattering), Cerenkov radiation. Radiation reaction: Abraham –Lorentz formula, Physical basis of radiation reaction.	25%

Teaching-Learning Methodology	Lectures using traditional blackboard teaching, Tutorials, class assignments as well as the ICT tools for effective delivery of the content.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1	Apply Maxwell equations in analysing the nature of electromagnetic field in different material media.
2	To analyse various electromagnetic phenomena based on basic physical quantities through the fundamental Maxwell equations.
3	To describe the nature of electromagnetic wave, its propagation through different media and understand the behaviour of e m waves at different interfaces.
4	Understand the working of waveguides structures propagating TE, TM or TEM modes, e.g., rectangular or circular waveguides, with design components.
5	Understand structure of resonant cavity, mathematical description for storage of electromagnetic energy as different modes and computation of its quality factor Q.
6	Understand the working principles of electromagnetic wave propagation through vacuum and material media, be able to compute the energy and power distribution of

	various types of antenna.
7	Understand the details of the production and propagation of radiation produced by a extended objects as well as moving (relativistic and non-relativistic speed) point charged particles their classifications.
8	Understand working details and the technological requirements of charged particle accelerators and radiation sources.
9	Compute the power distribution of the radiation and the energy loss to the radiating charged particle.

Suggested References:

Sr. No.	References
1	Classical Electrodynamics by J D Jackson, 2nd Ed; Wiley Eastern Ltd.(1975).
2	Introduction to Electrodynamics by David J Griffiths, 3rd Ed Prentice Hall, India, (2002).
3	Classical electromagnetic Theory by Jack Vanderlinde, John Wiley & sons,Inc.(1993).
4	Elements of Electromagnetics by Sadiku 2nd Ed.OxfordUniv.Press. Inc. (1995).
5	Classical Electrodynamics by Griener, Springer Verlag, New York, Inc. (1998).

On-line resources to be used if available as reference material

On-line Resources
eceweb1.rutgers.edu/~orfanidi/ewa/ https://webhome.phy.duke.edu/ (for both mathematical physics and classical electrodynamics) www.phy.duke.edu www.freebookcentre.net (Free ElectroDynamics Books Download) http://www.saha.ac.in/web/e-library/library-open-e-resources

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