

SC513T					Classical Electrodynamics & Basic Plasma Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

**COURSE OBJECTIVES**

- To provide the basic understanding of Maxwell's equations, electromagnetic waves and potentials
- To develop the concepts of relativistic electrodynamics
- To understand the dynamics of a single particle of Plasma in time varying fields.
- To introduce the properties of Plasma in terms of Boltzman equation and as a fluid.
- To introduce the basic concepts of magnetohydrodynamics.
- To introduce the techniques of Plasma production and applications.

**UNIT 1 Introduction to Electrodynamics****15 Hrs.**

Electrodynamics Before Maxwell; Maxwell's Equations; Maxwell's Equations in Matter; The Continuity Equation Poynting's Theorem; Newton's Third Law in Electrodynamics; Maxwell's Stress Tensor; Electromagnetic Waves: Waves in One Dimension; Boundary Conditions: Reflection and Transmission; Electromagnetic Waves in Vacuum; Energy and Momentum in Electromagnetic Waves; Potentials and Fields; The Potential Formulation; Lorentz Force Law in Potential; Liénard-Wiechert Potentials.

**UNIT 2 Electrodynamics and Relativity****15 Hrs.**

The Special Theory of Relativity: Einstein's Postulates; The Geometry of Relativity; The Lorentz Transformations; The Structure of Spacetime; Relativistic Mechanics; Relativistic Energy and Momentum; Relativistic Kinematics and dynamics; Relativistic Electrodynamics; Magnetism as a Relativistic Phenomenon; The Field Tensor; Electrodynamics in Tensor Notation; Relativistic Potentials

**UNIT 3 Radiative charge particle dynamics and magnetohydrodynamics****15 Hrs.**

Radiation from an accelerated charge, Larmor formula, bremsstrahlung and synchrotron radiation, multipole radiation, dispersion theory, radiative reaction, radiative damping, scattering by free charges; applications to wave-guides, fibres and plasmas. The Vlasov Equation, Plasma as a Conducting Fluid, The Langevin Equation, Fundamental Equations of Magnetohydrodynamics.

**UNIT 4 Plasma production and applications****15 Hrs.**

dc discharge, rf discharge, photo-ionization, tunnel ionization, avalanche breakdown, laser produced plasmas, Langmuir probe. Medium and short wave communication, plasma processing of materials, laser ablation, laser driven fusion, magnetic fusion.

**Max. <60> Hrs.****COURSE OUTCOMES**

On completion of the course, student will be able to

CO1 - Correlate the laws of electromagnetism with Maxwell's equations

CO2 - Understand and learn the concepts related to electromagnetic waves and the potential formulation

CO3 - Acquire the basic knowledge of relativity and understand the concepts relativistic electrodynamics

CO4 - knowledge of the properties of Plasma in terms of Boltzman equation and as a fluid

CO5 – knowledge of the basic concepts of magnetohydrodynamics.

CO6 – knowledge of the techniques of Plasma production and applications

**TEXT/REFERENCE BOOKS**

1. Classical Electrodynamics by John David Jackson (3rd Ed., Wiley, 1998)
2. Introduction to Electrodynamics by David Griffiths (3rd Ed., Benjamin Cummings, 1999)
3. Principles of Electrodynamics by Melvin Schwartz (Dover Publications, 1987)
5. Modern Problems in Classical Electrodynamics by Charles A. Brau (Oxford Univ. Press, 2003)
6. Electrodynamics of Continuous Media by L. D. Landau and E. M. Lifshitz & L. P. Pitaevskii (Oxford, 2005)
7. Goldston, R. J., and P. H. Rutherford. *Introduction to Plasma Physics*. Philadelphia, PA: IOP Publishing, 1995.
8. J.A. Bittencourt, *Fundamentals of Plasma Physics*, Springer, 2004

9. Krall, N. A., and A. W. Trivelpiece. *Principles of Plasma Physics*. Berkeley, CA: San Francisco Press,  
10. Wesson, J. *Tokamaks*. 3rd ed. Oxford, UK: Oxford University Press, 2004.  
11. Miyamoto, K. *Plasma Physics for Nuclear Fusion*. Cambridge, MA: MIT Press, 1989

**END SEMESTER EXAMINATION QUESTION PAPER PATTERN**

**Max. Marks: 100**

Part A/Question: 3 Questions from each unit, each carrying 3 marks

Part B/Question: 2 Questions from each unit, each carrying 8 marks

**Exam Duration: 3 Hrs**

36 Marks

64 Marks