PH-9102

Plasma Physics

L	T	P	C
4	1	0	5

Course outcomes:

After successful completion of the course, the students should be able to

CO1: Define plasma state, give examples of different kinds of plasma and explain the parameters characterizing them

CO2: Analyze the motion of charged particles in electric and magnetic fields

CO3: Determine the velocities, both fast and slow (drift velocities), of charged particles moving in electric and magnetic fields that are either uniform or vary slowly in space and time.

CO4: Classify the electrostatic and electromagnetic waves that can propagate in magnetized and non-magnetized plasmas, and describe the physical mechanisms generating these waves.

CO5: Define and determine the basic transport phenomena such as plasma resistivity, diffusion (classical and anomalous) and mobility as a function of collision frequency and of the fundamental parameters for both magnetized and non-magnetized plasmas.

CO6: Explain the concept of plasma instability, and analyze the instabilities based on the dispersion relation

CO7: Discuss interaction between particles and waves, Landau damping

CO8: Explain the use of thermonuclear fusion for energy production, and discuss plasma confinement.

CO/PO Mapping

S-strong, M-medium and W-weak indicate the strength of correlation

COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	W	W	W		W		M	S	S	S	S
CO2	S	S	S	M	S	W	M	W	M	W		M
CO3	M	W	M	W	W	S	S	S	S	M	S	S
CO4	S	S	M	M	W	M	M		M	S	W	W
CO5	M	S	S	W	S		S	M			M	W
CO6	M	W	M	W	W	S	S	S	S	M	S	S
CO7	S	S	W	M	W	M	M		M	S	W	W
CO8	M	S	S	W	S		M	M			M	M

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UNIT-I

Basics of Plasmas:
Occurrence of plasma in nature, definition of plasma, concept of temperature, Debye shielding and plasma parameter. Single particle motions in uniform E and B, non-uniform magnetic field, grad B and curvature drifts, invariance of magnetic moment and magnetic mirror. Simple applications of plasmas.
10 Hrs

Plasma Waves:
Plasma oscillations, electron plasma waves, ion waves, electrostatic electron and ion oscillations perpendicular to magnetic field, upper hybrid waves, lower hybrid waves, ion cyclotron waves. Light waves in plasma.
10 Hrs

Plasma Diagnostics Techniques:
Single probe method, Double probe method, Use of probe technique for measurement of plasma parameters, Microwave method and Spectroscopic methods
8 Hrs

UNIT-II

Boltzmann and Vlasov Equations:
The Fokker Planck equation, integral expression for collision term, zeroth and first order moments, the single equation relaxation model for collision term. Applications of kinetic theory to electron plasma waves, the physics of Landau damping, elementary magnetic and inertial fusion concepts.
10 Hrs

Non-linear Plasma Theories:
Non-linear Electrostatic Waves, KdV Equations, Nonlinear Schrodinger Equation, Solitons, Shocks, Non-linear Landau Damping. Non-linear Effects: Introduction, SHEATHS, ion acoustic shock waves, Ponderomotive force, Parametric Instabilities.
10 Hrs

Plasma Applications:
Source of power (MHD generator and Controlled thermonuclear fusion), Generation of microwaves utilizing high density plasma, plasma propulsion, materials processing with plasma arcs, plasma processing and fabrication (ion implantation in solids, plasma deposition and etching, paint spraying), Plasma chemistry and Pollution control (thermal, non-thermal, electrostatic precipitation, corona).
12 Hrs

Total: 60 Hrs

BOOKS:

1. Introduction to Plasma Physics and Controlled Fusion: F F Chen-Springer, 1984
2. Fundamental of Plasma Physics: S R Seshadri-American Elsevier Pub. Co. 1973.
3. Industrial Plasma Engineering: J. R. Roth, IOP Publishing, Ltd 1995.
4. Plasma Physics: S.N.Sen, Pragati Prakashan, Meerut, second edition, 1996.
5. Glow Discharge Processes: Brian Chapman, John Wiley & Sons, 1980.

c/BOS

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