M. Tech. / VI Sem.

NUCLEAR SCIENCE AND TECHNOLOGY

Paper NST 626— Plasma Physics and Nuclear Fusion Reactors – II

Time: 3 hours

Maximum Marks: 70

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any four questions. All questions carry equal marks.

(1) (a) Derive an expression for the diamagnetic current in the plasma. Explain with the help of a schematic diagram the origin of this current. (5)
(b) Show that hot plasma is diamagnetic. (3)
(c) Describe equilibrium Z pinch. Obtain an expression for the radius of pinch and the total current that is confined by the pinch. (9.5)

(2) (a) Show using drifts that plasma cannot be confined in a pure toroidal field. (6)
(b) Calculate the confinement time for a 10 keV hydrogen ion in toroidal field of 50 kG in a toroidal vessel of major radius of 100 cm and minor radius of 10 cm.(8)
(c) How is the plasma confinement achieved in a tokamak and Stellarator? (3.5)

Q 3 (a) What is a flux function? Show that the total current $J$, plasma pressure $P$ and safety factor $q$ are flux functions. (3)
(b) Describe the equilibrium of a plasma ring in conduction vessel along major axis. What is the position of magnetic axis with respect to the geometric centre of the vessel? (5)
(c) Derive the Grad-Shafranov equation for the plasma equilibrium in a tokamak. (9.5)
(4) (a) Give the expression for the MHD stability operator $F(\xi)$ where $\xi$ is the Lagrangian displacement. Show that $F(\xi)$ is self adjoint. State the condition for the MHD stability in terms of the eigen values of $F(\xi)$. (8)

(b) Using energy principle, derive the stability condition for the force free fields. (9.5)

(5) (a) Show that a homogenous infinite plasma confined in a uniform magnetic field is stable to perturbations travelling along the magnetic field lines. What is frequency of the oscillations? (8)

(b) Show that the plasma supported against gravity by the magnetic field is unstable? Obtain the expression for the growth rate of this instability. (9.5)