H-55019

Seat No._____

M. Sc. (Part-I) Examination

April / May – 2003

Physics : Paper-II

(Classical Mechanics, Orbital Mechanics, Electrodynamics, Plasma Physics, Statistical Mechanics)

(New Course)

Time : **3** Hours] [Total Marks : **100**

Instructions : (1) All questions carry **equal** marks.

(2) Symbols have their **usual** meanings.

(3) Calculator can be used.

1 (a) Show that a spinning top initially at rest is released at θ_1 under the action of gravity has a precessional velocity at other angle θ_2 is given by

$$\dot{\phi}_2 = \frac{2\,mgl}{I_3 W_3}$$

(b) Write a short note on limit cycles.

OR

1 (a) (i) What are canonical transformations ? Show, by taking suitable generating function, that co-ordinate and momentum are interchangable.

(ii) Show that no two perpendicular components of angular momentum can be taken as canonical momenta simultaneously.

(b) Obtain an exact solution of the non-linear equation

$$\ddot{x} + w_0^2\, x - \left(\frac{w_0^2}{\sigma}\right) x^3 = 0$$

Does it give the same result as the method giving an approximate solution.

2 (a) Write short notes on (any **two**) of the following :

(i) Right ascension and declination co-ordinate system.

(ii) Sun's apparent annual movement on celestial sphere.

(iii) Orbital elements.

(b) An earth satellite has the following elements

T = 3 hours e = 0.20

Determine its eccentric anomaly (E)

1 hour after its perigee passage.

OR

2 (a) Derive the following expressions :

(i) $r = a(1 - e\cos E)$

(ii) $\tan(f/2) = \sqrt{\frac{1+e}{1-e}}\tan(E/2)$

(b) An earth satellite has the following elements.

T = 12 hours e = 0.80

Determine its eccentric anomaly (E)

1 hour after its perigee passage.

3 (a) An infinite straight wire carries the current

$I(t) = 0$ for $t \le 0$

$= q_0\,\delta(t)$ for $t > 0$

Find the resulting electric and magnetic fields.

(b) Obtain $\vec{E}$, $\vec{B}$ for an arbitrary distribution of charges and currents when

$$V\left(\vec{r}, t\right) = \frac{1}{4\pi \in_0}\left[\frac{Q}{r} + \frac{\hat{r}\cdot\vec{p}(t_0)}{r^2} + \frac{\hat{r}\cdot\dot{\vec{p}}(t_0)}{rc}\right] \quad \text{and}$$

$$\vec{A}\left(\vec{r}, t\right) = \frac{\mu_0}{4\pi}\frac{\dot{\vec{p}}(t_0)}{r}$$

(c) Discuss radiation damping and obtain

$$m\left(\dot{\vec{V}} - \tau\,\ddot{\vec{V}}\right) = \vec{F}_e$$

where $\tau = \dfrac{e^2}{6\pi \in_0 mc^3}$

[Hint : $W = \dfrac{e^2(\dot{\vec{V}})^2}{6\pi \in_0 C^3}$]

OR

3 (a) If $\dfrac{dP}{d\Omega} = \dfrac{1}{4\pi \in_0}\dfrac{q^2a^2}{4\pi c^3}\dfrac{\left[(1-\beta\cos\theta)^2 - (1-\beta^2)\sin^2\theta\cos^2\phi\right]}{(1-\beta\cos\theta)^5}$

then find $P = \dfrac{1}{4\pi \in_0} 2/3 \dfrac{q^2a^2}{C^3} r^4$

where $r = \dfrac{1}{\sqrt{1-\beta^2}}$

(b) find $\vec{\rho}$ and $\langle P \rangle$ if $\vec{E} = -\dfrac{\mu_0 p_0 w^2}{4\pi}\left(\dfrac{\sin\theta}{r}\right)\cos w\left(t - \dfrac{r}{c}\right)\hat{\theta}$

and $\vec{B} = -\dfrac{\mu_0 p_0 w^2}{4\pi c}\left(\dfrac{\sin\theta}{r}\right)\cos w\left(t - \dfrac{r}{c}\right)\hat{\phi}$

(c) Discuss dispersion in dilute gases and obtain

$$n^2 = 1 + \sum_\alpha \frac{\left(e^2/m \in_0\right) N\ f_\alpha}{\left(w_\alpha^2 - w^2\right) - i l_\alpha w}$$

4 (a) (i) Show that the pressure tensor is

$$\overleftrightarrow{P} = \begin{bmatrix} p & 0 & 0 \\ 0 & p & 0 \\ 0 & 0 & p \end{bmatrix} \text{ where } \quad p = nkT .$$

(ii) Obtain Liouville equation for $f^{(N)}$.

(b) Considering the uniform electric field in the region between the plates of a large parallel plate capacitor obtain the transformation rules for electromagnetic fields.

OR

4 (a) (i) Obtain second moment equation.

(ii) Discuss the system of B.B.G.K.Y. equation and obtain.

$$\frac{\partial f^{(1)}}{\partial t} + \vec{V}_1 \cdot \vec{\nabla}_{r_1} f^{(1)} + \vec{A} \cdot \vec{\nabla} v_1 f^{(1)}$$

$$+ N \vec{\nabla}_{v_1} \cdot \int \vec{a_{12}} - f^{(2)} \, d\vec{r}_2 \, d\vec{V}_2 = 0$$

(b) Show that the electric and magnetic fields can be combined into a single entity called field tensor which is an antisymmetric second-rank tensor. Is this tensor gauge invariant ?

5 (a) Explain cluster integrals using the method of diagramatic analysis for the evaluation of general virial coefficients for an imperfect gas.

(b) Discuss the phenomenon of gas-liquid condensation.

OR

5 (a) Show that the long range order parameter (ρ) goes to zero near curie temperature T_C. The temperature dependence being $(T_C - T)^{1/2}$.

(b) Explain the term Johnson noise. State and prove Nyquist theorem.