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SB-3437

M. Sc. (Part - I) Examination

March / April – 2011

Physics : Paper - I

Classical Mechanics & Electrodynamics

Time : 3 Hours] [Total Marks :70

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **M.Sc. (Part - 1)**

Name of the Subject :

☛ **Physics : Paper - 1**

☛ Subject Code No. : **3 4 3 7** ☛ Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Use separate answer book for each section.

(3) Symbols used have their usual meaning.

(4) Figures to the right indiacate full marks

SECTION - I

1 (a) What role internal forces play on the motion of the center of mass of a system of particles ? - Explain. **2**

(b) What is the physical significance of the Lagrange's undetermined multipliers ? **2**

(c) State Kepler's laws of planetary motion. **3**

(d) How many independent generalized coordinates are needed to specify the configuration of a rigid-body in space ? - Explain **2**

(e) Given. **2**

$$L\left(x, \dot{x}, \theta, \dot{\theta}\right) = \frac{1}{2} m \dot{x}^2 + \frac{1}{2} m r^2 \dot{\theta}^2 - mg(l, x)\sin\theta$$

Derive the Lagrange equations of motion.

2 (a) A particle of mass m is moving with velocity v_r in a frame rotating with angular velocity w. Derive an expression for the effective force on the particle as measured by an observer in the rotating frame. **4**

(b) What is meant by areal velocity ? Show that it is constant in a conservative central force field. **3**

(c) A particle of mass m is constrained to move on the surface of a cylinder $x^2 + y^2 = R^2$. The particle is subject to a force directed towards the origin and proportional to the distance of the particle from the origin. Using Lagrange equations of motion show that the motion is simple harmonic along the cylinder axis. **5**

OR

2 (a) A given Lagrangian is independent of time. Is any quantity conserved ? Can we say that total energy is conserved ? Why ? **2**

(b) What is Rayleigh dissipation function ? What is its physical significance ? **3**

(c) Why centrifugal force and Coriolis forces are called pseudo forces ? - Explain. **2**

(d) Given : **5**

$$V(r) = \frac{-a}{r^3}(a > 0)$$

Plot the effective potential and discuss possible motions for given E and l.

3 (a) What is meant by principal axes transformation for rigid-bodies ? What is the expression for total rinetic energy and angular momentum of a rigid-body under this transformation ? **3**

(b) What are the advantages of Hamilton's formulation over the Lagrange's formulation for the case of cyclic coordinates ? **2**

(c) Define lagrange and Poisson brackets. What is the relationship between the two brackets ? **2**

(d) Find the normal modes of vibration of two pendulums length l coupled to each other through their ends by a spring of spring constant k. **5**

OR

3 (a) What is meant by canonical transformations ? 2

(b) Discuss the arguments leading to Hamilton's -Jacobi equations. What is Hamilton's principal function ? 3

(c) Express Hamilton's equations of motion in terms of Poisson brackets. 2

(d) Show that the transformation $Q = \ln\left[(1/2)\sin p\right]$, $p = q\cot p$ is canonical. 5

SECTION - II

4 (a) Distinguish clearly between the electric vectors E and D and similarly B and H. 2

(b) Explain the uniqueness theorem for the solution of an electrostatic problem. 2

(c) Define Dirac delta function and hence the Green's function. 2

(d) Highlight two important differences between electrostatics and magnetostatics. 2

(e) Draw a neat diagram for the plane electromagnetic wave showing the field vectors E and B, propagation vector k and the Poynting vector S. 2

(f) What is plasma ? Give two examples of its occurrence in nature. 1

5 (a) Starting with Gauss' Law in electrostatics deduce its differential form and hence obtain Poisson's equation for scalar potential $\Phi(r)$. 5

(b) Explain the method of images with a simple application in electrostatics. 5

(c) What do you understand by multipole expansion of a charge distribution ? 2

OR

5 (a) Write the Laplace equation in spherical polar coordinates (r,θ,φ) and derive its general solution if the electrostatic potential Φ is spherically symmetric. 5

(b) Electric current i flows through a circular loop of radius a. Assuming the Z-axis to be perpendicular to the plane of the loop passing through its centre, find the magnetic induction B at a distance L on the axis. 5

(c) State and explain Ampere's circuital law. 2

6 (a) Discuss the physical contents of the Maxwell equations of electrodynamics. **5**

(b) Consider a rectangular wave guide of dimensions a and b with $a<b$. Find the lowest cut-off frequency in Hz, in the dominant mode TE_{01}. **5**

(c) What is Lorentz force ? **2**

OR

6 (a) What is skin depth for a medium ? Calculate the skin depth for a metal with conductivity 10^7 mhos/m corresponding to rf frequency 100 MHz. **5**

(b) Derive an expression for plasma frequency ω_p. **5**

(c) What is Debye screening in plasma ? **2**