T.Y. B.Sc Sem V Term Apr 2018

Physics (Old) (CBSGS) New

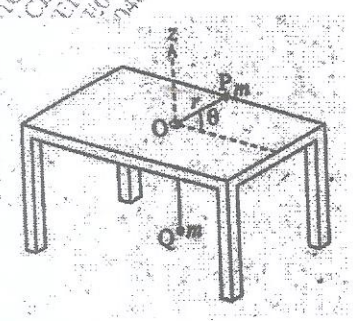
Q. P. Code : 35334

(2 1/2 Hours) [Total Marks : 75

N.B. : (1) **All** questions are **compulsory**.
(2) **Figures** to the **right** indicate **full** marks.
(3) Draw **neat** diagrams wherever **necessary**.
(4) Symbols have usual meaning unless otherwise stated.
(5) Use of **non-programmable** calculator is allowed.

1. (a) Attempt any **one**:---
   (i) Write the equations of motion for a particle inverse square field and find its solution. Hence obtain equation of the eccentricity. **10**
   (ii) State and prove Larmor's theorem. **10**
   (b) Attempt any **one**:---
   (i) State and prove Kepler's second law. **5**
   (ii) Prove that the time derivative of rotating vector **B** with respect to a fixed frame is given by **ω x B**. **5**

2. (a) Attempt any **one**:---
   (i) Describe the D'Alembert's principle in detail and derive Lagrange's equations using this principle. **10**
   (ii) Two equal point masses m are connected by a string of length ℓ which passes through a small hole at O on a frictionless horizontal plane. The suspended mass can move up or down without friction. The particle P is given an initial velocity v_0 at right angles to string OP when the length of OP = a. Let r be the instantaneous distance OP while θ is the angle between OP and a fixed line through O on the horizontal plane. **10**
   a) Set up the Lagrangian for the system.
   b) Write equation of motion of P in terms of r.



   (b) Attempt any **one**:---
   (i) Derive an expression for the kinetic energy of a system of particles in generalized coordinates. **5**
   (ii) Use Lagrangian formalism to find the differential equation for a compound pendulum which oscillates in a vertical plane about a fixed horizontal axis. **5**

3. (a) Attempt any **one**:---
   (i) Derive an expression for the equation of continuity for the motion of continuous matter. **10**
   (ii) Derive expressions for Euler's equations of motion of a rigid body. **10**
   (b) Attempt any **one**:---
   (i) Consider a fluid flow given by $\vec{v} = by\,\hat{\imath}$ in a coordinate system S and find out: (i) is the fluid incompressible, (ii) is the flow irrotational. **5**
   (ii) Prove that for a symmetric top the pure precession is possible only if the minimum value of ω_3 is given by $\omega_3 = \sqrt{\frac{4Mgl\,I\cos\theta}{I_3^2}}$. **5**

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4. (a) Attempt any **one:---**

(i) State Equation of a logistic map. Tabulate suitable values of x_n and x_{n+1} to draw the logistic maps for (1) $\lambda = 0.7$ and (2) $\lambda = 2.5$. Find the corresponding fixed points. Starting with $x_n = 0.8$, draw the iterations, on the map to show that the fixed points are stable attractors. **10**

(ii) Stating various forces involved in a driven damped anharmonic oscillator formulate the Duffing's equation and hence obtain its reduced form by suitable rescaling. With the help of graphical representation, discuss features of the numerical solution of the equation for the two cases: (1) $\gamma = 0.1$, $f = 0.5$ and (2) $\gamma = 0.1$, $f = 3$. **10**

(b) Attempt any **one:---**

(i) Show Graphical illustration of potential energy of an anharmonic oscillator constructed using hard spring and subjected to a conservative force: $F(x) = -k(x + \alpha x^3)$ for $k = \pm 1$. Comment on the stability of the oscillations in each case. **5**

(ii) Draw an equilateral triangle. Join midpoints of the triangle to obtain four equilateral triangles. Repeat same procedure successively for the three triangles except the middle triangle to obtain Sierpinski gasket. Hence find the fractal dimension. **5**

5. (a) Attempt any **one:---**

(i) Find the precessional time period of the plane of the oscillations of a Foucault pendulum when it is: 1) at the equator. 2) at the north pole **4**

(ii) Calculate the height of geostationary satellite from the surface of the earth. ($G=6.67 \times 10^{-11}$ SI units, $M = 5.98 \times 10^{24}$ kg, R=6400 km) **4**

(b) Attempt any **one:---**

(i) Write a short note on constraints. **4**

(ii) Prove that when a coordinate q_i does not occur explicitly in the Lagrnagian function, the corresponding momentum p_i is constant. **4**

(c) Attempt any **one:---**

(i) Three point masses of mass m each are placed at three corners O, A and B of the triangle. The coordinates of O, A and B are (0,0,0), (2,2,0)and (2,-2,0) in coordinate frame (x,y,z). Show that if the system behaves as a rigid body, the axes, OX, OY and OZ are the principal axes of the body. **4**

(ii) The water is flowing at a steady rate through a pipe. The pressure at two points A and B are 7000 N/m^2 and 4000 N/m^2 respectively. The point B is 0.5 m above the point A. If speed of water at A is 3 m/s, find the speed at B. density of water is = 1000 kg/m^3. **4**

(d) Attempt any **one:---**

(i) In a variation of Cantor set, a line segment is divided into five equal segments and the middle (center) one is removed. Then this process is continued on each of the remaining four segment. Find the fractal dimension of the resulting set. **3**

(ii) Write a note on Lyapunov exponent. **3**

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