Ref. No. Ex/IT/PHY/T/112/2017(S)

BACHELOR OF ENGINEERING EXAMINATION, INFORMATION TECHNOLOGY 2017
(1^{st} year, 1^{st} Semester)
PHYSICS 1A

Time : Three hours

Full Marks: 100

Answer any five

1. (a) What do you mean by central force and give two examples of central force. Show that angular momentum is conserved in a central force field. 2 + 2 + 3

   (b) An annular disc of 100 g and radii 10 and 15 cm rolls such that its centre has a velocity 50 cm/s, Calculate its kinetic energy. 5

   (c) Derive the moment of inertia of an uniform solid cylinder of radius r, length l and mass m , about an axis through the centre of mass perpendicular to the geometric axis. 8

2. (a) A particle is moving in a XY plane under the action of a force given by $\vec{F} = (x^2 + y^2)\hat{i} + cxy\hat{j}$. where c is a constant. Find the value of c, for which the force $\vec{F}$ is conservative. Calculate the work done by the force in moving a particle along the path from (0,0) to (0,2) and then from (0,2) to (3,2). 3 + 4

   (b) Define unit vectors in cylindrical coordinate system. Express the vector $\vec{A} = 2z\hat{i} - 3x\hat{j} + y\hat{k}$ in cylindrical coordinates (ρ, ϕ, z) and identify A_ρ, A_ϕ and A_z. 3 + 5

   (c) A point moving in a plane has co-ordinates x = 3, y =4 and has components of speed $\dot{x} = 5$ cm/s . $\dot{y} = 8$ cm/s at some instant of time. Find the components of speed in polar coordinate systems, r, θ along the directions $\hat{r}$ and $\hat{\theta}$ 5

3. (a) Write down the equation of continuity in the context of fluid flow. Prove Torricelli's theorem from Bernoulli's equation 1+4

   (b) Explain the concept of streamline and turbulent motion. What is Reynold's number. 3 + 2

   (c) What is the origin of viscosity of any fluid? State the assumption of Poiseuille method and hence derive the expression for the coefficient of viscosity. 2 + 8

4. (a) Show that the total energy of a particle executing Simple Harmonic Motion is conserved. 4

   (b) The phenomenon of beats occurs due to the superposition of two sound wave-trains of nearly equal amplitudes and frequencies propagating in the same direction. Show that number of beats per second is the difference of the two component frequencies. 5

(c) Write down the equation of forced vibration in the presence damping force. Draw the resonance curves for different damping coefficients. Define sharpness of resonance. 1+ 2 + 2

(d) Write down the differential equation of a plane progressive wave. Explain the concept wave group. Obtain the expression for the the group velocity. 1 + 2 + 3

5. (a) State the assumptions of kinetic theory of gas. Get an expression for pressure from kinetic theory. Prove Avogadro's low from kinetic theory

(b) What is the kinetic interpretation of temperature. Prove that for an ideal gas $\frac{1}{2}mc^2 = \frac{3}{2}KT$, where m is the mass of the molecule. 15 + 5

6. (a) Discuss the microscopic and macroscopic description of a thermodynamic system. What is thermodynamic equilibrium. State zeroth law of thermodynamics 6 + 1 + 2

(b) State and explain the first law of thermodynamics. 6

(c) Prove that for an ideal gas $C_p - C_v = R$. $2\frac{1}{2}$

(d) If there are 2 gm mole of a gas kept at a constant temperature of 0°C and if this gas is compressed from a volume of 4 litres to 1 litres. what would be the work done in Joules. $2\frac{1}{2}$.

7. (a) Get an expression for the efficiency of a Reversible Engine, describing clearly the working principle of such engine.

(b) An ideal Carnot Engine takes heat from a source at 317^0C and delivers heat into the sink at 117^0C. If 500 kcal heat is taken from the source, how much work is done.

(c) What do you mean by entropy? 12 + 5 + 3

8. (a) The intensity distribution due to a double-slit diffraction is given by $I = I_0\frac{sin^2\beta}{\beta^2}cos^2\gamma$, where, $\beta = \frac{\pi}{\lambda}bsin\theta$ and $\gamma = \frac{\pi}{\lambda}dsin\theta$. Symbols have their usual meaning. find the positions of maxima and minima. 2

(b) How many interference maxima do you expect within the central diffraction maximum? If $d = 4b$, calculate the missing orders of interference maxima. 2+1

(c) Consider a double-slit of slit width $b = 5\times10^{-2}$ cm and separation by a distance d = 0.1 cm, illuminated by a monochromatic light of wavelength 6×10^{-5} cm. If a convex lens of focal length 10 cm is place beyond the double slit arrangement, calculate the positions of the maxima inside the first diffraction minimum. 5

(d) Consider the formation of Newton's rings when two closely spaced wavelengths (λ_1 = 5890 Å and λ_2 = 5896 Å) are present. Calculate the thickness, t, of the air film and corresponding order of the ring at which fringe system will completely disappear. If the plano convex lens is raised vertically by an amount t, the interference fringe will be washed out. Find out the vertical separation of the lens for which fringe system will again reappear. 5

(e) Give an example of an interference experiment where division of wavefront is used. Derive the working formular to measure the fringe width of such interference experiment. 5