Ref. No.: EX/EE/Ph/T/1A/2018

Bachelor of Electrical Engineering Examination, 2018

(Ist Year, 1st Semester)

PHYSICS -IA

Time: 3 Hours **Full Marks: 100**

Answer **any five (5)** Questions

1. (a) What does Curl of a vector field mean? State Stoke's theorem.

(b) Define central force. Give two examples.

(c) Prove that central force is conservative.

(d) Prove that (i) Grad $(1/r) = -\mathbf{r}/r^3$ (ii) div $(\mathbf{r}) = 3$, $\mathbf{r}$ is a position vector of a point.

(e) If $\vec{r}$ be the position vector of a point, prove that $\vec{\nabla} r^n = n r^{n-2}\vec{r}$

(4+4+4+5+3)

2. (a) Which properties of the oscillators are responsible for executing the oscillation?

(b) Distinguish free, under damped and over damped oscillation.

(c) What is beat? Show that the beat frequency is equal to the difference between the frequencies of the component oscillation.

(d) A mechanical harmonic oscillator of mass m and stiffness constant k is subjected to a damping force proportional to its velocity. The oscillator is driven by a force $F = F_0 \cos \omega t$. Set up the differential equation of motion of the oscillator and obtain the steady state solution. Discuss amplitude and velocity resonance and its conditions.

(2+3+2+6+5+2)

3. (a) Define coefficient of viscosity of a liquid. What is its dimension?

(b) Distinguish between stream line and turbulent motion.

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(c) Deduce Poiseuille's equation for the flow of liquid through a narrow horizontal tube.

(d) Water flows through a horizontal tube of length 20 cm and internal radius 0.081 cm under a constant head of the liquid 20 cm high. In 12 minutes 864 cc of liquid issues from the tube. Calculate the coefficient of viscosity for water. The density of water is 1 gm/c.c and g= 981 cm/sec^2. Also verify that the conditions for the streamline flow exist. (3 + 3+ 8 + 4+2 =20)

4. (a) Explain the term "Moment of Inertia". Hence define the term "radius of gyration". Prove perpendicular axis theorem for a laminar body.

(b) Compare the moment of inertia of a uniform circular disc about a diameter with that about a tangent to the disc in its own plane.

(c) Calculate the moment of inertia of a spherical shell about one of its diameters.

(d) A disc of mass 50 gm and diameter 2 cm rolls with a velocity 5 cm/ sec. Calculate the kinetic energy of translation and rotation . ((2+ 2+ 3) + 3 + 6 +4 =20)

5. (a) Show that the dark and bright fringes produced in Young's experiment are equally spaced.

(b) Fringes are produced with monochromatic light of wavelength 689 nm. A thin film of glass of refractive index 1.53 is placed normally in the path of one of the interfering rays. The central fringe is found to move to a position occupied by the fifth bright band from the centre. Calculate the thickness of the glass plate. Derive the required expression.

(c) What do you mean by fringes of equal inclination and fringes of equal thickness?

(d) In Newton's ring experiment, the diameter of m^{th} dark ring is 8 mm and the diameter of $(m+5)^{th}$ dark ring is 12 mm. If the radius of curvature of the lower surface of the lens is 10 m, find the wavelength of light used. Derive the required mathematical expression.

(6+2+3+3+2+4)

6. a) State zeroth law of thermodynamics. What do you mean by thermodynamic equilibrium?

b) State the first law of thermodynamics along with its mathematical form. Apply this law to deduce the difference of molar specific heats of gases

$$C_P - C_V = \left\{\left(\frac{\partial U}{\partial V}\right)_T + P\right\}\left(\frac{\partial V}{\partial T}\right)_P$$

Hence prove, for an ideal gas, $C_P - C_V = R$.

(c) Using first law of thermodynamics prove the adiabatic equation of an ideal gas

i.e. $PV^{\gamma} = constant.$

d) Obtain an expression for work done by an ideal gas during an isothermal and adiabatic expansion. (4+8+4+4)

7. a) What do you mean by reversible and irreversible processes? Give one example of each.

b) Explain the working of a Carnot cycle by plotting P-V diagram and deduce its efficiency.

b) The efficiency of a Carnot engine is $\frac{1}{6}$. If the temperature of the sink is decreased by 60 K, the efficiency becomes $\frac{1}{3}$. Find the temperature of the source and the sink.

c) Define entropy. Explain what you mean by the principle of increase in entropy of the universe.

(4+8+4+4)

8. (a) State and explain Heisenberg uncertainty principle.

(b) Calculate the de Broglie wavelength of a (i) 1 gm ball with velocity 1m/s and that of

(ii) an electron with velocity of 10^7 m/s.

(c) Using Schrodinger equation show that the energy of a particle confined within a one dimensional box is quantized. Find the expectation value $\langle x \rangle$ of the particle in the ground state.

(d) An electron is confined to a box of 10^{-10} m of width (L). Find its permitted energies.

(mass of electron = $9.11 \times 10^{-31}\ kg,\ h = 6.625 \times 10^{-34}\ J - s$) (2+4+10+ 4)