Indian Institute of Engineering Science and Technology, Shibpur

B.Tech 1st semester Mid Sem Examination, 2021

Physics (PH 1101)

Full Marks: 30   **Time: 45 min**

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Answer all the questions

(Use separate papers for Group I & II and upload them separately.)

Group-I

1. a) Prove that $(\vec{A} \times \vec{B}).(\vec{B} \times \vec{C}) \times (\vec{C} \times \vec{A}) = \{\vec{A}.(\vec{B} \times \vec{C})\}^2$

b) Find $\phi(r)$ such that $\vec{\nabla}\phi = \frac{\vec{r}}{r^3}$ when $\phi(1) = 0$.

c) Show that $\vec{F} = (2xy + z^3)\hat{\imath} + x^2\hat{\jmath} + 3xz^2\hat{k}$ is a conservative force field.

d) Evaluate $\iint_S \vec{F}.\hat{n}dS$, where $\vec{F} = 4xz\hat{\imath} - y^2\hat{\jmath} + yz\hat{k}$ and S is the surface of the cube bounded by $x=0$, $x=1$, $y=0$, $y=1$, $z=0$, $z=1$. [1.5+2+1.5+2.5]

2. a) Prove that electromagnetic wave is transverse in nature.

b) Let $\vec{E} = (0, E_0 \sin(kx + wt), 0)$ be the electric field of some electromagnetic plane wave. What is the direction of propagation? Find magnetic field.

c) Write down Maxwell's equations in S.I units.

d) Write down the Poynting's theorem. Explain each term in it. [2.5+1.5+2+ 1.5]

Group-II

1. a) In the forced vibration of a system distinguish between amplitude resonance and velocity resonance.

b) If θ is the phase difference between the velocity and applied force, then what is the value of $cos\theta$ at resonance?

c) A mass of 10g is acted on by a restoring force of 50 dynes per cm and a resisting force of 20 dyn. sec/cm. Find the frequency of the oscillation. [4+1+2.5]

2. a) If Ψ is the wave field parameter, then show that the wave equation for a plane wave in one dimension is $\frac{\partial^2 \Psi}{\partial t^2} = c^2 \frac{\partial^2 \Psi}{\partial x^2}$.

b) A standing wave on a wire is described by *y(x,t) = 0.5 sin(0.0035πx)cos(642t) cm.*

(i) Find the equations (y_1 & y_2) of two travelling waves that make up this standing wave.

(ii) What will be the length of the wire if it oscillates with its 2nd harmonic?

c) Write down the relation (in terms of λ) between the group velocity (V_g) and the phase velocity (V_p) of a wave. [3+(2+1)+1.5]