53 (PH 101) ENPH

2014

ENGINEERING PHYSICS

Paper : PH 101

Full Marks : 100

Pass Marks : 30

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(A)* What are scalar and vector fields ? Give examples. When does a vector field said to be irrotational ? 4+1=5

    (B) Write the expression of Laplacian in Cartesian, Cylindrical and Spherical co-ordinate. 5

    (C) Find a unit vector normal to the surface given by $\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}+\dfrac{z^2}{c^2}=1$ at the point (a, b, c) . 5

(D) Calculate the divergence and curl of the following vector at (1, 1, 1). $4+1=5$

$$\vec{A}=4x\hat{i}-2y^2\hat{j}+z^2\hat{k}$$

State if the vector is selenoidal or irrotational.

2. (A) State and prove Gauss's law in electrostatics. $1+3=4$

(B) A spherical volume charge density distribution is given by— $3\times4=12$

$$\rho=\rho_0\left(1-\frac{r^2}{a^2}\right); r\leq a$$

$$= 0 \qquad ; r>a$$

(i) Calculate the total charge Q contained in the sphere.

(ii) Find the electric field intensity outside the charge distribution.

(iii) Find the electric field intensity inside the charge distribution.

(iv) Show that the maximum value of E is at $r=0\cdot745a$.

(c) What is the electric flux density (D) and electric field intensity (E) due to a line distribution $\lambda = 0 \cdot 5 \, nC/m$ along z-axis at a point (4, 3, 5) ?   4

3.   (A) Write the *four* Maxwell's fundamental equations of the electromagnetic wave in differential form.   5

(B) Show that electromagnetic wave is transverse in nature.   6

(C) Show that the transfer of energy in electromagnetic wave is along the direction of propagation of wave.   3

(D) Write a short note on working principle of laser.   6

4.   (A) State Biot-Savart's law and Amperie's law with mathematical expressions.   4

(B) Apply Biot-Savart's law to obtain the expression of magnetic field intensity due to a long straight wire carrying current (I).   8

(C) What is resonance ? What is the condition of resonance in LCR circuit ? $1+1+6=8$

A resistance $R = 160\Omega$, a capacitance $C = 15\mu F$ and an inductance $L = 230mH$ are connected in series with a source of variable voltage $E(t) = 36\, sin(120t - \phi)$.

Calculate *(i)* the impedance *(Z)* of the circuit *(ii)* the current amplitude I_0. *(iii)* Phase angle (ϕ) and *(iv)* resonant frequency (f_R).

5. *(A)* What do you mean by angular momentum of a body ? Derive the relation between torque and angular momentum. $2+3=5$

(B) The equation of a transverse wave in a stretched wire is

$$y = 2\, sin\, 2\pi \left(\frac{t}{0 \cdot 01} - \frac{x}{30} \right) cm.$$

Find amplitude, wavelength, frequency and speed of the wave.   5

(C) Define Poisson's ratio and derive the relation between Poisson's ratio and other moduli of elasticity.   7

(D) A cantilever of length 0·5 *metre* has a depression of 15*mm* at its free end. Calculate the depression at a distance of 0·3 *meter* from the fixed end. 3

6. *(A)* Deduce the equation of motion of a simple harmonic oscillator and show that the frequency of the oscillator is independent of the amplitude. 5

(B) What are forced oscillations ? Obtain an expression for the amplitude of forced oscillations. Explain resonance. 2+3+2=7

(C) The quality factor Q of a sonometer wire is 2×10^2. On plunking, the wire emits a note of frequency 120 Hz. Calculate the time in which the amplitude falls to $\left(1/e^2\right)$ of the initial value. 4

(D) A mass on the end of spring oscillates with an amplitude of 5*cm.* at a frequency of 1*Hz*. At $t = 0$ the mass is at its equilibrium position $(x = 0)$. Find the possible equation describing the position of the mass as a function of time, in the form of $x = A cos(\omega t\ f\phi)$. What are the numerical values of A, ω and ϕ ? 4

7. (A) Describe the experimental set up of Fresnel's biprism experiment. How would you determine the wavelength of light by this experiment ? 3+4=7

(B) In a double slit experiment done with $\lambda = 480\,nm$ the 5th maximum goes into the Second minimum if a transparent material of thickness t and $\mu = 1\cdot56$ is placed in front of one of the slits. What is t ? 4

(C) Determine the radius of the drop of water falling through air, if the terminal velocity of the drop is $1\cdot2\,cm/s$. Assume the coefficient of viscosity for air $=1\cdot8\times10^{-4}$ and the density of air $=1\cdot21\times10^{-3}\,gm/cc$. 4

(D) Derive Poiseulle's formula for the rate of flow of liquid through a capillary tube. Mention the limitations of the formula. 5

8. (A) State the first law of thermodynamics. Express it mathematically and explain its physical significance. 4

(B) Describe Carnot's cycle and obtain an expression for the efficiency of an ideal heat engine in terms of temperature.   5

(C) What do you mean by entropy ? Show that entropy remains constant in reversible process by increases in irreversible process.

           5

(D) Calculate the change in entropy when $10gm$ water at $60°C$ is mixed with $30gm$ of water at $20°C$.

   4

(E) Write short notes on perfectly black body.

           2