53 (PH 101) ENPH

2013

(May)

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 do you mean by gradient of scalar field ? Show that the gradient of a scalar field represent the irrotational vector field. 2+3=5

   [B] Write the expression of Laplacian (∇^2) in Cartesian, Cylindrical and Spherical co-ordinates. 6

   [C] State Divergence theorem and Stoke's theorem. 4

[D] Obtain divergence and curl of the following vector. 5

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

2. [A] Obtain the integral and differential form of Gauss's law in electrostatics. 5

[B] A spherical volume charge density distribution is given by 8

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

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

(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 $\vec{E}$ is at $r = 0 \cdot 745a$.

[C] Write Laplace's and Poisson's equation in cylindrical and spherical co-ordinates. What are the general procedures for solving Laplace's and Poisson's equation ? 3+4=7

3. *[A]* Write the differential form of the four Maxwell's field equations and state the laws from which these equations are taken. 5

[B] Show that electromagnetic wave is transverse in nature. 7

[C] State Biot-Savart's law. Apply Biot-Savart's law to obtain the expression of magnetic flux density due to a long straight conductor carrying current (I). 8

4. *[A]* Discuss the main components of Laser. Explain the principle of Laser action. 5+5=10

[B] What do you mean by hysteresis ? Explain the terms 'coercivity' and 'retentivity' with the help of hysteresis loop. 7

[C] Explain briefly with examples about para, dia and ferromagnetism. 3

5. *[A]* Deduce the equation of motion of a simple harmonic oscillator and show that the frequency of the oscillator is independent of the amplitude. Also show that the energy is proportional to the square of amplitude. 2+3+3

[B] What are forced oscillations ? Obtain an expression for the amplitude of forced vibrations and deduce the condition for resonance. 2+4=6

[C] The amplitude of an oscillator of frequency 200 per second falls to $\frac{1}{10}$ of its initial value after 2000 cycles.
Calculate

(i) its relaxation time

(ii) its quality factor

(iii) time in which its energy falls to $\frac{1}{10}$ of its initial value

(iv) damping constant. 6

6. [A] What do you mean by angular momentum of a body ? Derive the relation between torque and angular momentum. 2+3=5

[B] An object of mass $0 \cdot 2\,kg$ is hung from a spring whose spring constant is $80\,N/m$. The body is subjected to a resistive force given by $-bv$, where v is its velocity (m/s) and $b = 4\,Nm^{-1}\,sec$. Set up the differential equation of motion for free oscillations of the system and find the period of such oscillations. 4

[C] The equation of a transverse wave in a stretched wire is

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

Find amplitude, wavelength, frequency and speed of the wave. 4

[D] State Stoke's law and apply it to find the terminal velocity of a spherical ball falling through a fluid. 7

7. *[A]* Derive the expression for fringe width in bi-prism experiment. Discuss the conditions for interference of light. 4+1=5

[B] the distance between the slit and bi-prism and between the bi-prism and the screen are $50cm$ each. The angle of bi-prism is 179° and its refractive index is $1 \cdot 5$. If the distance between successive fringes is $0 \cdot 0135cm$, calculate the wavelength of light. 5

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

[D] Establish the necessary condition for a combination of two lenses, in contact to act as an achromat. 3