Gau-c-13/112

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53 (PH 101) ENPH

2013

(December)

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)* Find a unit normal vector to the surface given by $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ at the point (a, b, c). 4

(B) Express vector $\vec{A}=x\hat{i}+y\hat{j}+z\hat{k}$ in cylindrical and spherical co-ordinates. 5

(C) Write the expression of ∇ and ∇^2 in cylindrical and spherical co-ordinates. 5

Contd.

(D) Verify divergence theorem for the vector $\vec{A} = p\hat{p} + z\hat{z}$ for the volume enclosed by the surface of the cylinder with circular base $x^2 + y^2 = a^2$ and height (h). 6

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

(B) Apply Gauss's law to obtain the electric field intensity due to infinite line charge distribution (λ). What is the electric field intensity due to a line charge distribution $\lambda = 0.5 nC/m$ along z-axis at a point (4, 3, 5)? 3+2=5

(C) A spherical charge distribution is given by

$$\rho = \rho_0 \left(\frac{r}{a}\right)^{3/2}.$$

Calculate

(i) how much charge lies within a sphere of radius $r = a$ and

(ii) electric field intensity $\vec{E}$ at $r = a$ 5

(D) Determine potential and intensity of electric field inside and outside a spherical cloud of electrons with a uniform volume charge density $\rho_v = -\rho_0$ (ρ_0 is a positive quantity) for $0 \leq r \leq b$ and $\rho_v = 0$ for $r > b$ by using Laplace's and Poisson's equations. 6

3. (A) Write the four Maxwell's fundamental equations of electromagnetic wave in differential form. 4

(B) Show that the transfer of energy in electromagnetic wave is along the direction of propagation of wave. 5

(C) In a material for which $\sigma = 5.0\, s/m$ and $\varepsilon_r = 1$, the electric field intensity is $E = 250\, sin 10^{10} + (V/m)$. Find the conduction and displacement current densities and the frequency at which they have equal magnitudes. 5

(D) Write the main features of laser light. How does laser action takes place ? 2+4=6

4. *(A)* State Biot-Savarts law and Ampere's law. 4

(B) Apply Biot-Savarts law to obtain the expression of magnetic field intensity due to a circular coil of N turns at its centre. 5

(C) Apply Ampere's law to obtain the expression of magnetic field intensity due to an infinite solenoid at any point on its axis. 5

(D) What is the condition of resonance in a LCR circuit ? A resistance $R = 160\,\Omega$, a capacitance $C = 15\,\mu F$ and an inductance $L = 230\,mH$ are connected in series with a source of variable voltage $E(t) = 36 sin(120t - \phi)$. 6

Calculate *(i)* the impedance (z) of the circuit *(ii)* the current amplitude I_0 *(iii)* phase constant ϕ and *(iv)* resonant frequency f_R.

5. *(A)* Write the relation between angular momentum and torque. 2

(B) A particle of mass m move in a circle of radius r at an angular speed ω about the z-axis in a plane parallel to the x-y plane passing through the origin. Find the magnitude and direction of the angular momentum $\vec{L}$ relative to the origin. 3

(C) How does the depression of the end of a cantilever depend upon its Young's modulus ? 2

(D) Prove that $\sigma = \frac{3K - 2h}{6K + 2h}$ 3

(E) Derive Poisevilli's equation. 3

(F) Water is conveyed through a horizontal tube 10*cm.* in diameter and 5*km.* in length at a rate of 30 *litres/second.* Assuming only viscous resistance, calculate the pressure required to maintain this flow. Viscosity may be taken as 0.01*cgs* units. 4

(G) Write short notes on Bernoulli's equation. 3

6. (A) What is spherical aberration ? Describe with suitable diagram

(i) Longitudinal spherical aberration

(ii) Lateral spherical aberration. 1+2×2=5

(B) Explain the interference pattern produced by a biprism with white light. 2

(C) A Fresnel's biprism with angle 1°80′ and $\mu = 1.52$ is used to form interference fringes. Find the width of fringe with light of wavelength $6536A°$ when the distance between the sources and the prism is $20cm.$ and that between the prism and screen is $80cm.$ 3

(D) What are Lissajous' figure ? Discuss the formation of Lissajous' figures when the periods of the two vibrations are equal and the phase difference is zero. 1+3=4

(E) Write the differential equation of SHM and write expression for the velocity and acceleration of a particle in SHM. At what point are these quantities zero and maximum ? 3

(F) A body describing a simple harmonic motion executes 100 complete vibrations per minute, and its speed at its mean position is $15ft.$ per second. What is the length of its path ? What is its velocity when it is half way between its mean position and an extremity of its path ? 3

7. (A) What is forced vibration ? Discuss mathematically, the vibration of system executing damped simple harmonic motion when subjected to an external periodic force. What is sharpness of resonance ? 1+4+2=7

(B) An object of mass 0.2 *kg* is hang from a spring whose spring constant is 80 *N/m*. The object is subjected to 9 resistive force given by $-bv$, where v is its velocity in *meters* per *second*. If the damped frequency is 0.995 of the undamped frequency, what is the value of the constant b ? 3

(C) The amplitude of oscillator of frequency 200 *cycles/sec.* falls to $\frac{1}{10}$ of its initial value of 200 *cycles*. Calculate *(i)* its relaxation time *(ii)* quality factor and time in which energy falls to $\frac{1}{10}$ of its initial value. 6

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

$$y = 2 \sin \pi \left(\frac{t}{0.02} - \frac{x}{30} \right) cm$$

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

8. *(A)* State first law of thermodynamics. Give its physical significance. What are the limitations of first law? 5

(B) State and prove Carnot's theorem. 5

(C) Define Entropy. Show that for a reversible adiabatic process the entropy of the system remains constant. 5

(D) Calculate the increase in entropy when 1*gm.* of ice at – 10°*C* is converted into steam at 100°*C*. (Given : Specific heat of ice = 0.5 ; Latent heat of 80 *cal/gram*, Latent heat of steam = 540 *cal/gram*). 5