53 (PH 101) ENPH

2019

ENGINEERING PHYSICS

Paper : PH 101

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* Prove that the curl of gradient of a scalar function is always zero. 5

(b) State and explain Gauss's divergence theorem. 5

(c) If $\vec{A} = \hat{i}x^2 + \hat{j}3xz^2 - \hat{k}2xz$ and $\vec{B} = \hat{i}xy + \hat{y}2yz + \hat{k}3zx$, find the divergences of $\vec{A}$ and $\vec{B}$. 3+3=6

(d) Write the physical interpretation of divergence and curl of a vector point function. 2+2=4

Contd.

2. *(a)* Derive Poiseuille's formula by dimensional analysis. 6

(b) What are the three elastic constants? Derive the relation between these three constants. 3+9=12

(c) Why are the griders I shaped? 2

3. *(a)* State Gauss's law in electrostatics. Write it in integral and differential form. 3

(b) Apply Gauss's law in electrostatics to calculate the electric field intensity due to a uniformly charged sphere of radius (r') at a point situated at a distance (r) from the centre of the sphere for *(i)* $r > r'$ *(ii)* $r = r'$ *(iii)* $r < r'$. 8

(c) State Biot-Savart law and Ampere's law. 2+2=4

(d) Apply Biot-Savart law to calculate the magnetic field due to an infinitely long straight conductor carrying current (I). 5

4. *(a)* Write Faraday's law of electromagnetic induction and convert it into differential form. 1+3=4

(b) Write the Maxwell's four fundamental equations in electromagnetism. 4

(c) *(i)* Show that the electromagnetic wave travels with the speed of light. 2

(ii) Show that the electromagnetic wave is transverse in nature. 5

(d) What do you understand by displacement current? A circular cross-sectional conductor of radius $2mm$ carries a current $I_c = 2{\cdot}5\sin\left(5\times10^8\right)z\,\mu A$, what is the amplitude of the displacement current density if $\sigma = 35\mu_{s/m}$ and $\varepsilon_r = 1$? 2+3=5

5. *(a)* What is Laser? Write a short note on it. Describe spontaneous and stimulated emission. 7

(b) What is chromatic and achromatic aberration? Write a short note on Fresnel bi-prism. 6

(c) Calculate the longitudinal aberration for a lens made of crown glass having focal length of $50cm$. Given $\mu_C = 1{\cdot}5206$ and $\mu_F = 1{\cdot}5249$. 7

6. *(a)* Write short notes on Lissajous figures. 5

(b) How does elastic (mechanical) wave differ from electromagnetic wave ? 5

(c) Discuss the significance of simple harmonic motion. 3

(d) If two simple harmonic motion are superimposed to each other, then derive the expression for resultant motion. 7

7. *(a)* Which properties of a medium are responsible for propagation of wave through it ? 2

(b) What are the salient differences between sound wave and light wave ? 1

(c) Write the difference between progressive wave and stationary wave. 3

(d) What do you mean by resonance of wave ? Explain sharpness and Q-factor for this. 4

(e) A transverse harmonic wave on a string is described by,

$y(x, t) = 3{\cdot}0 \sin(36t + 0{\cdot}018x + \pi/4)$,

where x and y are in a *cm* and t in *s*.

(a) Is it a travelling wave or stationary wave ?

(b) What are the speed and direction of propagation ?

(c) What are its amplitude and frequency ?

(d) What is the initial phase at the origin ?

(e) What is the least distance between two successive crests in the wave ? 2×5=10

8. *(a)* What is the significance of 1st Law of Thermodynamics ? 2

(b) State 2nd Law of Thermodynamics in terms of Entropy. 2

(c) Write the difference between isothermal and adiabatic process. 3

(d) Write the working of Carnot engine. 5

(e) Write a short note on Black Body radiation. 5

(f) A steam engine delivers $5{\cdot}4\times10^{8}J$ of work per min and services $3{\cdot}6\times10^{9}J$ of heat per min from its Boiler. What is the efficiency of the engine? 3

Or

An electronic heater supplies heat to a system at a rate of 100 *W*. If the system performs work at a rate of $75J/s$, at what rate is the thermal energy increasing? 3