2017

PHYSICS

(Major)

Paper : 1.2

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—I

(Waves and Oscillations)

(*Marks* : 40)

1. *(a)* Write the dimension of damping constant. 1

(b) With increase in humidity the velocity of sound increases. Why? 1

(c) On the basis of absorption coefficient, distinguish between live room and dead room. 1

(d) What is the difference between amplitude resonance and velocity resonance? 1

2. *(a)* A particle executing simple harmonic motion has amplitude a. At displacement x from its mean position its velocity and acceleration are v and f respectively. Show that

$$v = \sqrt{f\left(\frac{a^2}{x} - x\right)}$$

(b) An external periodic force $F = F_0 \sin pt$ is applied on a body which is in damped vibration. If frequency of applied periodic force is equal to natural frequency of the vibrating body, then energy resonance is occurred. Explain how damping affects on the sharpness of resonance. 2

(c) Explain why Laplace correction is required in the formulation of velocity of sound. 2

3. Answer any *two* questions :

(a) A particle of mass m executes simple harmonic motion with frequency ω and amplitude a. Derive the differential equation of the motion of the particle from the conservation of total energy. 5

(b) A particle is subjected to two rectangular simple harmonic motions of different amplitude and phase simultaneously. If their frequencies are in ratio 2 : 1, then find the expression for the resultant motion. If phase difference between the two SHMs is $\frac{\pi}{2}$, then draw the Lissajous figure. 4+1=5

(c) Write two differences between progressive wave and stationary wave. A wave of frequency 400 Hz is travelling with a velocity 800 m/sec. How are two points situated whose displacement differs in phase by $\frac{\pi}{4}$? 2+3=5

Answer any *two* questions :

4. What are phase velocity and group velocity? Establish a relation between them. Two waves $y_1 = 0 \cdot 03 \cos(7t - 10x)$ metre and $y_2 = 0 \cdot 03 \cos(5t - 8x)$ metre are superposed in a medium. Calculate the group velocity. 2+5+3=10

5. Write the Fourier theorem. A periodic function with amplitude A and time period T is given as $f(t) = A\left(1 - \frac{t}{T}\right)$ for $0 \le t \le T$.

Express the above function in Fourier series. Plot the first two terms of the Fourier series. 2+6+2=10

6. *(a)* Derive an expression for allowed frequencies of vibration for a stretched string tied at both ends. 3

(b) Find an expression for the energy eigen-modes for vibration of string fixed at the two ends and plucked at the middle. 7

7. A sound is sounded in a closed auditorium of total surface area S and volume V. If I_0 be the initial intensity and u be velocity of the sound, then show that the intensity decreases as

$$I = I_0 e^{(-\alpha S u/4V)t}$$

where a is the absorption coefficient of wall of the auditorium. If the intensity level of sound increases by one decibel, then calculate the percentage increase of intensity of the sound. 7+3=10

SECTION—II

(Ray Optics)

(*Marks* : 20)

Answer *any* **four** questions

8. Using Fermat's principle, derive the formula

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

for spherical refracting surface. The symbols have their usual meanings. 5

9. What do you mean by refraction matrix? Find out an expression of refraction matrix which transforms the incident ray into refracted ray. 1+4=5

10. Two thin lenses are placed coaxially at finite distance apart. Find the condition of achromatism for the combination. 5

11. Derive Helmholtz equation of paraxial optics. 5

12. Using matrix method, find the positions of the two principal points and two nodal points for a combination of two convex lenses of focal lengths 20 cm and 10 cm situated at a distance of 10 cm in air. 5

13. *(a)* What do you mean by aplanatic surface? 1

(b) Distinguish between pin cushion and barrel-shaped distortion. 4

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