Total No. of printed pages = 7

3 (Sem 1) PHY M2

2015

PHYSICS

(Major)

Paper : 1.2

Full Marks – 60

Time – Three hours

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

SECTION – I

Marks – 40

1. (a) What do you mean by sharpness of resonance ? 1

(b) If a parameter whose unit is *meter* is Fourier Transformed what will be the unit in the Fourier plane ? 1

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(c) Plot the first two cycle of the wave starting from $t = 0$ represented by the wave equation

$$x = a \sin\left(\omega t + \frac{\pi}{4}\right).$$ 1

(d) What is the mean free path of sound wave in a room if the dimension of the room is $6 \times 4 \times 5$ m^3? Velocity of sound in the room is 350 m/s. 1

2. Answer any *two* questions : $6 \times 2 = 12$

(a) What are the characteristics of wave motion? A simple harmonic wave is represented by $y = 100 \sin\left(\frac{2\pi t}{T} + \alpha\right)$ and the time period is 30 sec. At time $t = 0$, the displacement is 50 cm.

(i) Calculate the phase angle at 7.5 sec.

(ii) Phase difference between two positions at an interval of 6 sec. $2+4=6$

(b) Write the properties of stationary longitudinal wave.

Two transverse sine waves, each of amplitude 4 mm wavelength 2m and time period 1s and in phase at $x = 0$, $t = 0$ are traveling along x-axis in opposite directions. Obtain the equation of the resultant wave. Calculate the maximum displacement at $x = 2.3$m. Find the positions of the nodes and antinodes. 2+4=6

(c) Show that in forced vibrations the response R is inversely proportional to the frictional force. 6

3. Answer any *three* questions : 8×3=24

(a) Show that composition of two simple harmonic vibrations of equal time periods with phase difference α acting at right angle forms an ellipse. If the ratio of the amplitude between the two waves is 2 then find the angle between the major axis of the ellipse with the x-axis when $\alpha = 0$.

Explain how the frequency of a tuning fork can be determined using Lissajous figure. 4+2+2=8

(b) Show that for a series LCR circuit, the discharging is of simple harmonic type when $\frac{R^2}{4L^2} < \frac{1}{LC}$ with natural frequency

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

A condenser of capacity 1uF, and inductance of 0.2 H and a resistance of 800Ω are connected in series. Check whether the circuit is oscillatory. 7+1=8

(c) Why the Laplace correction is required in the formulation of velocity of sound. Derive the formula for the velocity of sound in air by incorporating the Laplace correction.

Calculate the increase in velocity of sound in air per degree Celsius rise in temperature. 1+4+3=8

(d) Consider a periodic function of the form with time period T and amplitude a

$$f(t) = a\left(1 - \frac{t}{T}\right) \text{ for } 0 < t < T$$

express the above function in Fourier series. Plot first three terms of the Fourier series. 5+3=8

(e) The displacement y(x, t) of a plucked string along transverse direction satisfies the following wave equation $\frac{\partial^2 y}{\partial^2 x} = \frac{1}{v^2}\frac{\partial^2 y}{\partial^2 t}$

where $v = \sqrt{\frac{T}{p}}$ represents the speed of the transverse wave. T being the tension in the string and p, the mass per unit length. Find the displacement y(x, t) of the string under the following boundary conditions

(i) $y = 0$ at $x = 0$ and $x = L$ for all values of t

(ii) At $t = 0$

(a) $\frac{\partial y}{\partial t} = 0$ for all values of x

(b) $y(x, t = 0) = \frac{d}{a}x$ for $0 < x < a$ and

$$y(x, t = 0) = \frac{d}{L - a}(L - x) \text{ for } a < x < L$$

where L is the length of the string and d is the displacement of the string at a distance a from $x = 0$. 8

SECTION – II

Marks – 20

4. (a) What is achromatic doublet ? 1

(b) What do you mean by circle of least confusion? 1

(c) Under what condition the matrix method can be applied to an optical system ? 1

(d) Name one aberration each suffered by image when the point object is on-axis and off-axis for a lens. 1

5. Answer any *one* question : 4×1=4

(a) Find the matrix for a spherical surface of radius of curvature R separated by two media with refractive indices n_1 and n_2 when the object is placed in the first medium at a distance u from the surface. 4

(b) Derive the lens formula for thin lens using Fermat's principle. 4

6. Answer any *two* questions : 6×2=12

(a) Find the equivalent focal length of two lenses with focal lengths f_1 and f_2 separated by a distance *d*. Hence find the positions of the second principal point and second focal point. 4+2=6

(b) Show that the combination of two lenses (made of same material) can minimize the chromatic aberration if they are separated by a distance equal to the mean of the focal lengths of the two lenses. 6

(c) A thick equi-convex lens made of a material of refractive index 1.5 has radii of curvature of the two surfaces 0.4 cm. The thickness of the lens is 1 cm and lens is placed in air. Obtain the system matrix and determine the focal length and the position of the unit plane. 6