B.Sc.(Honours) Examination, 2019

Semester - II

Physics

Paper: BPC-22

(Waves & Geometrical Optics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***any four*** questions.

1. a) Define SHM. Why SHM is of central importance in the study of oscillations and waves? 1+2
   b) Show that the total energy of a particle executing SHM is constant and hence explain how the energy exchange takes place in SHM. 3+2
   c) Show that if the momentum of a particle executing SHM is plotted again its displacement, an elliptic curve is obtained. 2

2. a) State the principle of superposition and mention for what kind of equation is it valid? 1+1
   b) Two collinear SHMs acting on a particle are given by:

$$x_1 = A_1 \cos wt$$

$$x_2 = A_2 \cos(wt + \phi).$$

   Show that the resultant motion of the particle is simple harmonic. Also obtain the expression for amplitude and phase constant of the resultant motion in terms of A_1, A_2 and ϕ. 3+1+1
   c) A particle is subjected simultaneously to N simple harmonic motions of the same frequency. If the amplitude of each oscillation A_0 and ϕ is the phase difference between successive oscillations, show that amplitude of the resultant oscillation is given by,

$$A = A_0 \frac{\sin\left(\frac{N\phi}{2}\right)}{\sin\left(\frac{\phi}{2}\right)}.$$ 3

3. a) Show that the average energy of a weakly damped oscillator decays exponentially with time. 3
   b) Show that average power supplied to the forced oscillator during one cycle of the driving force is given by,

$$P = \frac{1}{2} F_0 \, w \, A_{ab}$$

   where A_{ab} is the amplitude of that part of the steady state displacement which is 90° out of phase with the driving force. 3
   c) Show that in the steady state, the time averaged input power equals the time averaged power dissipated through the friction. 2
   d) Show that there is no effect on the frequency of damped oscillations under the action of a constant frictional force. 2

4. a) State Fourier's theorem. 2
   b) Expand $f(x) = \begin{cases} x(\pi - x) & \text{for } 0 \le x \le \pi \\ x(\pi + x) & \text{for } -\pi \le x \le 0 \end{cases}$

   into Fourier Series with period 2π. 4
   c) Hence show that $1 - \frac{1}{3^3} + \frac{1}{5^3} - \frac{1}{7^3} + \ldots = \frac{\pi^3}{32}$. 2
   d) What do you mean by Half-range Sine Series and Half-range Cosine Series? 2

P.T.O.

5. a) State and explain Fermat's principle in Geometrical optics. 2
   b) Use it to prove the laws of reflection and refraction at a plane surface separating the media. 3+3
   c) Explain with neat diagram the law of reversibility of light rays. 2

6. a) Define longitudinal magnification, lateral magnification and angular magnification and hence establish the Smith-Helmholtz relation for magnification. 3+2
   b) Explain the terms first principal focus and second principal focus and hence show that, $\frac{f_1}{u} + \frac{f_2}{v} = 1$, where the symbols have their usual meanings. 1+1+3

7. a) What is chromatic aberration? Describe with suitable diagrams, the lateral and longitudinal chromatic aberrations. 1+2+2
   b) The focal length of an achromatic combination of two lenses in contact is 150 cm. If the dispersive powers of the materials of the two lenses are 0.018 and 0.027, calculate the focal lengths of the two lenses. 3
   c) What is Coma? How is it eliminated? 2

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