B.Sc.(Honours) Examination, 2019

Semester-II (CBCS)
Physics (Honours)
Core Course: CC-4
(Waves and Optics)

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

Questions are of value as indicated in the margin.
Answer ***any four*** questions.

1. a) Show that the total energy of a transversely vibrating string (vibrating in a particular mode) varies as the square of the frequency of vibration of that particular mode. 7
   b) Two vibrations along the same line are described by the equations
   $x_1 = 0.03 \cos 10 \pi t$
   $x_2 = 0.03 \cos 12 \pi t$
   where x_1 and x_2 are measured in metres and t in seconds. Obtain the resultant equation of motion. Find out the resultant amplitude (with proper justification) and the beat period. 1+1+1

2. a) A particle is subjected simultaneously to N number of simple harmonic oscillations having frequencies distributed uniformly between ν_1 and ν_2. If the amplitude of each oscillation is A_0, initial phase of each is zero and $\delta\nu$ is the frequency difference between the successive components, show that the resultant displacement of the particle is given by
   $$x(t) = A_0 \left\{ \mathrm{Sin}(\pi N \delta \nu t) / \mathrm{Sin}(\pi \delta \nu t) \right\} \mathrm{Cos}\left\{ \pi (\nu 1 + \nu 2) t \right\}.$$ 6
   b) Trace graphically the motion of a particle that is subjected to two perpendicular simple harmonic motions of equal frequencies, different amplitudes and phases differing by $\pi/4$. 4

3. a) Draw the necessary curved to illustrate the time variation of displacement, velocity, acceleration and total energy of a particle executing simple harmonic motion. You have to derive the necessary expressions and for simplicity, you can consider the phase constant to be zero. 1+1+1+2
   b) Distinguish between Fresnel and Fraunhofer class of diffraction. 1
   c) What are the necessary conditions to obtain permanent interference pattern? 2
   d) Draw the typical intensity distribution curve for Young's double slit experiment. 2

4. a) Show that the fringe width of the fringes formed by reflected light from a wedge shaped thin film varies inversely as the angle of inclination between the two film surfaces. (*You have to derive all the necessary expressions*). 6
   b) Monochromatic light is incident normally on a thin wedge-shaped film of transparent plastic of refractive index 1.42. Interference fringes are observed by reflected light with a separation of 0.26 mm between adjacent bright bands. If the wavelength of incident light is 5893 A^o, calculate the angle (in degree) of the wedge. 2
   c) A parallel beam of light of wavelength 5890 A^o is incident on a thin glass plate of refractive index 1.5, such that the angle of refraction inside the plate is 60^o. Calculate the smallest thickness of the glass plate which will appear dark by reflection. 2

5. a) Deduce the simplified expression (invoking the necessary physical conditions) for the diameter of m^{th} Newton's dark ring formed by a Convex lens in contact with a concave surface. 4
   b) What are the distinctive features between the interference fringes formed by bi-prism and by Lloyd mirror? 2

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c) In a Fresnel bi-prism experiment the base angle of the prism is 3^o and the refractive index of the material of the prism is 1.5. Interference fringes are formed with a source of wavelength 600 nm located 10 cm from the bi-prism. If the screen is placed at a distance of 1 m from the source, find the maximum number of fringes that can be observed. 4

6. a) Two coherent sources of intensity ratio "α" interfere and interference pattern is produced. Prove that in the interference pattern, the expression for the visibility is given by: 3

$$V = \frac{2\sqrt{\alpha}}{1+\alpha}.$$

b) Define the terms: (i) Monochromaticity, (ii) Coherence length. 1+1

c) Deduce the standard expression for the intensity distribution of the fringes formed by double slit through the process of Fraunhofer diffraction. 5

7. a) Show that in a diffraction grating with grating element 1.5×10^{-6} m and light of wavelength 500 nm, the fourth and higher order principal maximum are not visible. 2

b) What will be the nature of central spot of the ring system formed in Newton's ring experiments through reflected and transmitted beam of light? 1

c) Calculate the fractional change (in percentage) in fringe width in a Young's double slit experiment if the wavelength of the incident ray is changed from 400 nm to 0.6 μm. 2

d) Draw the intensity distribution pattern as a function of angle of diffraction for the diffraction that takes place through 5 numbers of slits. 2

e) Discuss the Fresnel's diffraction at an opaque circular disc. 3

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