[This question paper contains 4 printed pages.]

May 2013

870 *Your Roll No.* .....

B.Sc. (Hons.) / II **C**

PHYSICS – Paper XI

(Vibrations and Wave Optics)

Time : 3 Hours *Maximum Marks : 38*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **five** *questions in all,*
Question No. **1** *is compulsory.*
Attempt **one** *question from each Section.*

1. Attempt any **four** of the following :

(a) Show that superposition principle is true only in case of homogeneous linear equations.

(b) What are stationary waves ? How are they formed ?

(c) Compare the two methods of producing interference. Give two examples of each case.

(d) Explain what is meant by diffraction of light. Distinguish between Fresnel and Fraunhoffer classes of diffraction.

P.T.O.

(e) What is the role of compensating plate in Michelson interferometer ? (4x2)

SECTION A

2. (a) What do you mean by a system with two degrees of freedom ? Give examples. (2½)

(b) Two identical simple pendulums A and B, each of mass m and length l, have their bobs connected by a massless elastic spring of force constant k. The relaxed length of the spring is equal to the distance between the two bobs in the equilibrium position. Obtain the frequencies and configurations of the normal modes of the systems, assuming negligible damping. (5)

3. Prove that the general expression for displacement due to transverse vibration of a uniform flexible string of length l, linear density μ, fixed at ends x = 0 and x = 1 and stretched with a tension T is given by

$$y(x,t)\sum_{n=1}^{\infty}\sin\frac{n\pi x}{l}\left[A_n\cos\frac{n\pi vt}{l}+B_n\sin\frac{n\pi vt}{l}\right]$$

where $v=\sqrt{\frac{T}{\mu}}$ and A_n and B_n are arbitrary constants.

(7½)

SECTION B

4. (a) Write down the conditions for observing a sustained interference pattern. (2)

(b) Explain the formation of interference fringes with a biprism and calculated the f width. (3)

(c) A transparent plate of thickness 10^{-3} cm is placed in the path of one of the interfering beams of a biprism experiment using light of wavelength 5000 Å. If the central fringe shifts by a distance equal to width of ten fringes, calculate refractive index of the material of the plate. (2½)

5. (a) Obtain Airy's formula for transmitted light in Fabry-Perot interferometer. (4)

(b) Show that the fringes obtained with Fabry-Perot interferometer are sharper than the obtained with Michelson's interferometer. (3½)

SECTION C

6. (a) Discuss the intensity distribution of the Fraunhoffer diffraction obtained with a single slit, illuminated by a parallel beam of monochromatic light. (5)

(b) Light of wavelength 6000Å is incident on a slit of width 0.30 mm. The screen is place at a distance of 2 m from the slit. Find the distance between the first minima and the central maximum. (2½)

7. (a) State and explain Rayleigh's criterion of liming resolution. (3)

(b) Define dispersive power and resolving power of diffraction grating. Deduce expressions for these. What is the relation between dispersive power and resolving power. (4½)

SECTION D

8. (a) What is Cornu's spinal ? Discuss its properties. (3½)

(b) Using Cornus's spiral, explain the Fresnel diffraction pattern due to the single slit. (4)

9. (a) What is holography ? How is a hologram produced and how is the image reconstructed from it ? (6)

(b) Why does one require a highly monochromatic and spatially coherent source of light like a laser for holography ? (1½)

This question paper contains 4+2 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 6227

Unique Paper Code : 222202 D

Name of the Paper : **Oscillations and Waves (PHHT-204)**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **II**

Duration : **3 Hours** M. rks : 75

(Write your Roll No. on the top immediately on receipt of this question pa, er.)

Attempt *Five* questions in all including Q. No. 1 which is compulsory.

5×3=15

1. Do any *five* of the following :

(*a*) Find the time-period of vertical oscillations of liquid (density, ρ) filled in a uniform U-tube (area of cross-section, A). [Ignore viscous effects and take length of liquid column = L]

(*b*) Two simple pendulums having equal masses, M but different lengths, L_1 and L_2 ($L_2 > L_1$) are executing SHM with the same angular amplitudes. Which of the two pendulums has higher total energy ? And why ?

(*c*) Prove that the principle of superposition holds only for linear homogeneous differential equations.

P.T.O.

(*d*) For a wave in medium, the angular frequency ω and wave vector $\vec{k}$ are related by :

$$\omega^2 = \omega_0^2 + c^2k^2,$$

where ω_0 and c are constants. Prove that the product of group velocity and phase velocity is c^2.

(*e*) A point particle is executing SHM given by :

$$x = A \sin(\omega t + \theta)$$

What fraction of time period T is taken by a particle in going from amplitude A to $\frac{A}{2}$?

(*f*) Find the beat period of two vibrations along the same line, given by :

$$x_1 = A \cos 10\pi t$$

and $x_2 = A \cos 12\pi t$.

(*g*) Derive an expression for the total energy of a SHM.

(*h*) At what temperature will the speed of sound be double of its value at 0°C.

2. (*a*) Consider a mass *m* attached with two identical springs. Each spring has relaxed length a_0, equilibrium length a and spring constant k. Assuming that the springs are massless and the system executes small amplitude oscillations, show that the ratio of the frequency in transverse and longitudinal mode of oscillation is given by :

$$\frac{\omega_{trans}}{\omega_{long}} = \sqrt{1 - \frac{a_0}{a}}.$$ 9

(*b*) A uniform spring of constant k and finite mass m is loaded with a mass M. If m is not negligible compared to M, show that the period of vertical oscillations is given by :

$$T = 2\pi\sqrt{\frac{1}{k}\left(M + \frac{m}{3}\right)}. \qquad 6$$

3. (*a*) A particle is subjected simultaneously to N simple harmonic motions of the same frequency. If the amplitude of each oscillation is A_0 and ϕ is the phase difference between successive oscillations, show that amplitude of the resultant oscillation is given by :

$$A = A_0 \frac{\sin(N\phi/2)}{\sin(\phi/2)}.$$

(*b*) A particle is subjected to two perpendicular SHMs simultaneously :

$$x = A_1 \sin \omega t,\ y = A_2 \sin(2\omega t + \alpha).$$

Obtain Lissajous Figures (analytically or graphically) if $\alpha = \frac{\pi}{2}$ and π.

4. (*a*) The equation of motion of forced harmonic oscillator is given by :

$$m\ddot{x} + b\dot{x} + kx = F_0 \sin pt$$

(*i*) Find the steady state solution.

(*ii*) Find maximum amplitude of displacement.

(*b*) The amplitude of forced harmonic oscillator is same at two frequencies p_1 and p_2 the applied periodic force. Prove that the resonant frequency is given by :

$$p_{res} = \sqrt{\frac{p_1^2 + p_2^2}{2}}.$$

(*c*) Derive the expression for the time period of a compound pendulum. Hence, show th centre of suspension and centre of oscillation are interchangeable.

5. (*a*) Determine the frequencies of the two normal modes of double pendulum [shown in Fig. 1].

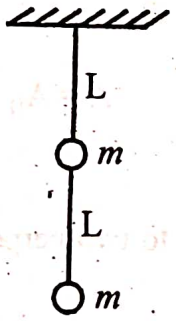


Fig. 1

(*b*) Two masses m_1 and m_2 are connected by a massless spring of spring constant k [as shown in Fig. 2]. The system is free to oscillate along the length of the spring. Show that the system oscillates with a frequency :

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}}, \text{ where } \mu = \frac{m_1 m_2}{m_1 + m_2}.$$

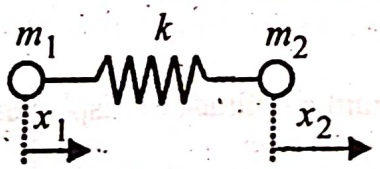


Fig. 2

6. (*a*) A uniform string of length L and linear density μ is stretched with tension T between the fixed ends at $x = 0$ and $x = L$. Starting from classical wave equation, prove that the general expression for transverse displacement $y(x, t)$ of the string is given by :

$$y(x, t) = \sum_{n=1}^{\infty} \sin\frac{n\pi x}{L}\left(A_n \cos\frac{n\pi v t}{L} + B_n \sin\frac{n\pi v t}{L}\right)$$

where, A_n and B_n are arbitrary constants and $v = \sqrt{\frac{T}{\mu}}$. 9

(*b*) What do you understand by plucked string ? Obtain the equation for the subsequent motion of the string if it plucked at $x = \frac{L}{3}$, through a transverse height *h*. 1,5

7. (*a*) Three equal masses *m* are equally spaced along a string of length 4L [as shown in Fig. 3]. The tension in the string is T.

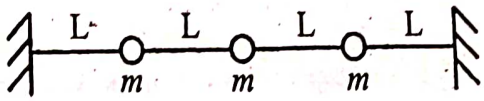


Fig. 3

Show that the three normal mode frequencies and the corresponding amplitudes of norma mode displacements are :

$\omega_1 = \omega_0\sqrt{2 - \sqrt{2}}$; $A_1 = \frac{C}{\sqrt{2}}, A_2 = C, A_3 = \frac{C}{\sqrt{2}}$

$\omega_2 = \omega_0\sqrt{2}$; $A_1 = C, A_2 = 0, A_3 = -C,$

$\omega_3 = \omega_0\sqrt{2 + \sqrt{2}}$; $A_1 = \frac{C}{\sqrt{2}}, A_2 = -C, A_3 = \frac{C}{\sqrt{2}}$

Hence, draw the normal modes of transverse oscillations.

$$\left[\text{Given : } \omega_n = 2\omega_0 \sin\frac{n\pi}{2(N+1)},\ A_p = C\sin\frac{pn\pi}{N+1}\right]$$

6,3

(*b*) Derive Newton's formula for the velocity of sound in gas. How Laplace modified this formula ?

3,3

3. (*a*) Distinguish between plane and spherical waves and give their mathematical representations.

4

(*b*) What is a stationary wave ? Deduce its equation. Prove that in case of stationary wave, no energy is transferred across any section of the medium.

1,2,3

(*c*) Prove that in Melde's experiment, the frequency of vibration of string in the longitudinal mode is half of that in the transverse mode of vibration.

5

This question paper contains 4 printed pages]

S. No. of Question Paper : 6236

Unique Paper Code : 222402

Name of the Paper : Optics [PHHT-412]

Name of the Course : B.Sc. (Hons.) Physics

Semester : IV

Roll No. | | | | | | | | | | | |

D

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *Five* questions.

Question No. 1 is compulsory.

Use of Non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following questions : 5×3=15

(*i*) Define the terms coherence length and coherence time.

(*ii*) What is the difference between interference and diffraction ?

(*iii*) What are achromatic fringes and how can we obtain them in principle ?

(*iv*) Define visibility of fringes and show that its value lies between zero and one.

(*v*) List important applications of Holography.

(*vi*) Why compensating plate is required in Michelson interferometer ?

P.T.O.

2. (*a*) Derive the conditions for dark and bright interference fringes seen in reflected light, when a thin parallel sided film is illuminated by monochromatic light. What will happen to the interference pattern if monochromatic light is replaced by white light ? 7

(*b*) Explain how an excessively thin parallel film seen in reflected white light appears. 3

(*c*) White light (4000 Å-7000 Å) falls normally upon a film of soapy water whose thickness is 5×10^{-5} cm and refractive index is 1.33. Which wavelength in this region will be reflected most strongly ? 5

3. (*a*) Describe the construction and working of a Michelson's interferometer. How will you use it to measure :

(*i*) Wavelength of monochromatic light

(*ii*) The difference in wavelengths between sodium D-lines. 5,3,3

(*b*) A Michelson interferometer illuminated with red light from cadmium source ($\lambda = 6438$ Å) is used to measure the distance between two points. Calculate this distance if 239 fringes pass the reference mark as the mirror is moved from one of the points to the other. 4

4. (*a*) Describe and explain the Fresnel diffraction pattern formed at a straight edge using Fresnel half period zones. Also draw the intensity distribution curve. 8

(*b*) The diameter of the first ring of a zone plate is 1.2 mm. If plane waves ($\lambda = 6000$ Å) fall on the plate, where should the screen be placed so that light is focused to a brightest spot ? 3

(*c*) Mention the difference between a zone plate and convex lens. What is a phase reversal zone plate ? 3,1

5. (*a*) Derive an expression for the intensity distribution in case of Fresnel's diffraction in terms of Fresnel integrals. 5

(*b*) Discuss the properties of Cornu's spiral. Show how the spiral can be used to obtain the intensity distribution pattern of a slit. 5,5

6. (*a*) Discuss and explain the Fraunhofer diffraction due to a double slit. What is the effect of :

(*i*) Increasing slit width and

(*ii*) Increasing the slit separation ? 5,2

(*b*) A plane wave ($\lambda = 6000$ Å) falls normally on a single slit of width 0.2 mm. Calculate the total angular width of the central diffraction maximum and also the linear width as observed on a screen placed 2 m away. 4

(*c*) Distinguish between the dispersive and resolving power of a plane transmission grating. 4

7. (*a*) Define the cardinal points of a lens system. What are their properties ? 6

(*b*) Show that the distance between nodal points is equal to the distance between principal points. 2

(*c*) Show that the principal points coincide with the nodal points of a lens system when medium on both sides of the system is the same. 2

(*d*) Two convex lenses of focal lengths 10 cms and 20 cms are placed 5 cms apart in air. Find the cardinal points of the system. 5

[This question paper contains 2 printed pages.]

Sr. No. of Question Paper : 1612

F-3

Your Roll No.....

Unique Paper Code : 2221303

- 3 DEC 2014

Name of the Course : B.Sc. (Hons.) Physics

Name of the Paper : Waves and Optics

Semester : III

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any five questions in all.
3. Question No. 1 is compulsory.

1. Attempt any five of the following questions : (3×5=15)

   (a) State and explain the superposition principle and linearity.

   (b) What are Temporal and Spatial coherence ?

   (c) $y = 0.5 \sin(314t - 12.56x)$ represents a simple progressive wave. If y and x are in meters and t in seconds, find (i) wavelength, (ii) speed and (iii) frequency of the wave.

   (d) Explain the phase reversal on reflection on the basis of Stoke's treatment.

   (e) How interference fringes are produced by using Lloyd's mirror ?

   (f) What are the conditions for obtaining sustained or permanent interference ?

2. Derive an expression for the superposition of n-collinear simple harmonic motions with equal frequency difference and hence explain the formation of beats. (8+7)

3. (a) What are Newton's rings ? Give the necessary theory for their formation. How would you use Newton's rings to measure the wavelength of light ? (2+6+4)

(b) In Newton's rings experiment the diameter of 10^{th} ring changes from 1.5 cm to 1.4 cm when a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid. (3)

4. (a) Distinguish between Fresnel and Fraunhofer class of diffraction. Give the theory of Fresnel's half period zone. Discuss the Fresnel's diffraction at a straight edge with the help of half period zones. (2+6+4)

(b) Calculate the radius of the first half period zone of a zone plate behaving like a convex lens of focal length 60 cm. Given, wavelength of light is 6000 Å. (3)

5. (a) Describe briefly the construction and working of Michelson's interferometer. How it can be used to measure the

(i) wavelength of a monochromatic light.

(ii) refractive index of a thin transparent sheet. (6+3+3)

(b) Draw a neat diagram to show the formation of interference fringes due to Fresnel's biprism. (3)

6. Discuss Fraunhofer diffraction due to single slit. Draw and discuss the curve indicating distribution of intensity in the diffraction pattern. (10+5)

7. Give the necessary theory to derive expression for the intensity distribution pattern in a plane transmission grating. Derive an expression for the resolving power of a plane transmission grating. (10+5)

8. Write short notes on any **two** of the following :

(a) Lissajous figures

(b) Fresnal's bi-prism

(c) Haidinger fringes and Fizeau fringes

(d) Kirchhoff's integral theorem (7.5×2=15)

This question paper contains 7 printed pages]

Roll No. | | | | | | | | | | | |

S. No. of Question Paper : 936

12 MAY 2015

Unique Paper Code : 222202 E

Name of the Paper : **Oscillations and Waves (PHHT-204)**

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : **II**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all including Q. No. **1** which is compulsory.

1. Attempt any *five* of the following : 5×3=15

(*a*) A wire of length 100 cm and of mass 1.25 g is stretched with a tension of 100 N. If the wire is set into vibration and touched lightly with a feather at a point one-third of its length from one end, calculate the frequency of the note emitted.

(*b*) What are beats ? What is the necessary condition to obtain them ?

(*c*) What are stationary waves ? Why are they called so ?

P.T.O.

(*d*) A particle executes SHM with amplitude A. If its starting point is :

(*i*) $\psi = +A$

(*ii*) $\psi = -A$

(*iii*) $\psi = +A/2$

find the different values of phase constant φ for the solution :

$$\psi(t) = A\cos(\omega t + \varphi).$$

(*e*) A solid cube of side *a* is made to under small oscillations about one of its sides as the asix of oscillation. Show that the frequency of oscillations is :

$$f = \frac{1}{2\pi}\sqrt{\frac{3g}{2\sqrt{2}a}}$$

Given $I = 2ma^2/3$.

(*f*) What are longitudinal and transverse waves ?

(*g*) Explain the difference between particle and wave velocity and give mathematical expression for each.

(*h*) The refractive index η of a gas is given by

$$\eta = \frac{c^2}{v^2} = \alpha + \beta k^2 - \frac{\gamma}{k^2}$$

where α, β and γ are constants, *k* is the wave number, *v* is the phase velocity and *c* is the speed of light in vacuum. Show that the group velocity is :

$$v_g = \frac{v}{\eta^2}\left(\alpha - \frac{2\gamma}{k^2}\right).$$

2. (*a*) Obtain the time period of oscillation of a compound pendulum and show that centres of suspension and oscillation are interchangeable. Obtain the value of the length for which the time period of the pendulum is a minimum. 10

(*b*) A smooth tunnel is bored through the earth along one of its diameters and a ball is dropped into it. Show that the ball will execute SHM with time period :

$$T = 2\pi\sqrt{\frac{R}{g}}$$

where R is the radius of earth and g is the acceleration due to gravity at the surface of earth. 5

3. (*a*) Two vibrations at right angles to each other are described by the equations :

$$x(t) = 3\sin(5\pi t) \text{ and } y(t) = 2\sin\left(5\pi t + \frac{\pi}{3}\right)$$

where x and y are expressed in centimeters and t in seconds. Construct the Lissajous curve for the combined motion using graphical method. 10

(*b*) Two pendulums are suspended one below another to form a double pendulum as shown Fig. (*i*). Show that the frequencies of two normal modes for small oscillations are given by :

$$\omega^2 = \left(2 \pm \sqrt{2}\right)\frac{g}{l}.$$ 5

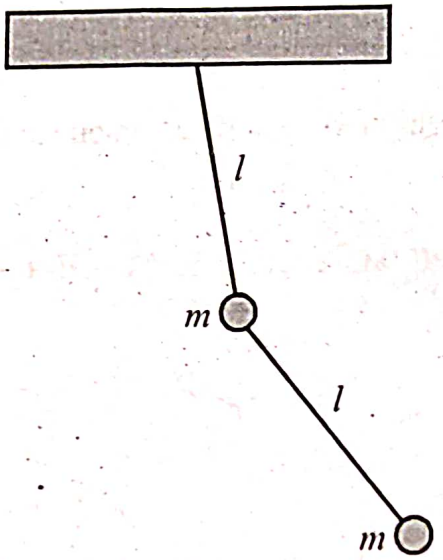


Fig. (*i*)

4. (*a*) A Helmholtz resonator consisting of a container of volume V_0 with a neck having a tube of radius *a* and length *l*. Neglecting any end corrections, show that the frequency of the resonator is :

$$f = \frac{av}{2\pi}\sqrt{\frac{\pi}{lV_0}}.$$ 10

(*b*) Two tuning forks A and B of nearly equal frequencies are employed to produce Lissajous figure. On slightly loading fork A, it is observed that cycle of change of figure slows down from 10 to 20 seconds. If the frequency of fork B is 256 Hz, determine the frequency of fork A before and after loading.. 5

5. (*a*) Establish the equation of motion of a damped harmonic oscillator subjected to a resistive force that is proportional to the first power of its velocity. If the damping is less than critical, show that the motion of the system is oscillatory with its amplitude decaying exponentially with time. 10

(*b*) A massless spring suspended from a rigid support carries a flat disc of mass 100 g at its lower end. It is observed that the system oscillates with a frequency of 10 Hz and the amplitude of the damped oscillator reduces to half its undamped amplitude value in 1 min. Calculate :

(*i*) the resistive force constant

(*ii*) the relaxation time of the system and

(*iii*) its quality factor. 5

6. (*a*) Derive the differential equation of motion for the transverse vibrations of a uniform flexible stretched string. Hence find the expression for the velocity of the subsequent wave motion. 10

(*b*) Prove that the expression for magnitude of the velocity of the waves formed on the surface of liquid (density ρ) under the combined action of gravity g and surface tension T is given by :

$$v = \sqrt{\frac{\lambda g}{2\pi} + \frac{2\pi T}{\rho\lambda}}$$

where λ is the wavelength of the wave. 5

7. (*a*) A uniform flexible string of length L and linear mass density μ is stretched between its two fixed ends ($x = 0$) and ($x = L$) with tension T. The string is plucked at $x = L/4$ with amplitude h and released. Starting from :

$$y(x, t) = \sum_{n=1}^{\infty} \sin\left(\frac{n\pi x}{L}\right)\left[A_n \cos\left(\frac{n\pi v t}{L}\right) + B_n \sin\left(\frac{n\pi v t}{L}\right)\right]$$

obtain and discuss the equation for subsequent motion of the string. 10

(*b*) Also obtain the expression for its total energy given that the general expression of total energy of a vibrating string is :

$$E_{total} = \frac{\mu\pi^2 v^2}{4L} \sum_{n=1}^{\infty} n^2\left[A_n^2 + B_n^2\right].$$ 5

8. (*a*) N identical particles of mass m are connected together by N + 1 identical massless springs constant k. The free ends of the extreme springs are rigidly fixed. Show that the frequency of normal modes of longitudinal oscillations are given by :

$$\omega_n = 2\sqrt{\frac{k}{m}} \sin\left[\frac{n\pi}{2(N+1)}\right].$$ 10

(*b*) The string of length $4a$ and under tension T has three equal masses placed at a, $2a$ and $3a$.

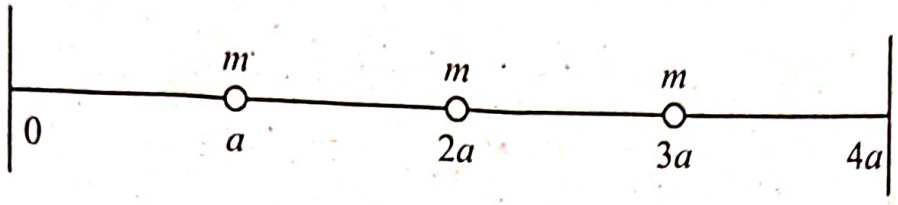


Fig. (*ii*)

Write the general expressions for the normal frequency and the corresponding amplitudes of the normal mode displacements. Draw the normal modes of transverse vibrations. 5

[This question paper contains 3 printed pages.]

Sr. No. of Question Paper : 946

E Your Roll No.....

Unique Paper Code : 222402

11 MAY 2015.

Name of the Course : B.Sc. (Hons.) Physics

Name of the Paper : Optics (PHHT-412)

Semester : IV

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any five questions in all.
3. Use of non-programmable scientific calculators is allowed.

1. Attempt any five of the following questions:

   (i) Distinguish between ordinary photography and Holography.

   (ii) Show that the deviation produced by a thin lens is independent of the position of the object.

   (iii) Derive the expression $\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2$ from Fermat's principle of extreme path.

   (iv) Give any three differences between temporal and spatial coherence.

   (v) Why do excessively thin films seen by reflected light appear dark?

   (vi) A plane wave of wavelength 5893 Å passes through a slit 0.5 mm wide and forms a diffraction pattern on a screen placed 1 m away from the slit and parallel to it. Calculate the separation of first dark band on either side of central maximum.

P.T.O.

(vii) Each slit of a double slit has a width of 0.15mm and the distance between their centres is 0.75 mm. Find the missing orders, in the diffraction pattern.

(viii) Compare the diffraction pattern in the case of circular aperture and circular disc. (5×3=15)

2. (a) Show that the focal length of a thick lens is given by:

$$\frac{1}{f} = (\mu - 1)[\frac{1}{R_1} - \frac{1}{R_2} + \frac{\mu - 1}{\mu} \cdot \frac{d}{R_1 R_2}]$$

Here μ is the refractive index of the material of the lens, R_1 and R_2 are the radii of curvature of the lens surfaces and d is the lens thickness along the axis. Discuss how the converging and diverging properties of such lenses vary with thickness. (10)

(b) Two thin convex lenses of focal lengths 20 cm and 5 cm are placed co-axially separated by a distance of 10 cm. Determine the position of the cardinal points for the combination. (5)

3. (a) Describe briefly the Fresnel hi-prism setup to obtain interference fringes. How its fringes are different from that of Liyod's mirror. (10)

(b) A bi-prism is placed 5 cm from a slit illuminated by sodium light (λ = 5890 Å). The width of the fringes obtained on a screen 75 cm from the bi-prism are 9.424×10^{-2} cm. What is the distance between the two coherent sources? (5)

4. (a) What do you mean by division of wavefront and division of amplitude? Derive an expression for the path difference indroduced by a parallel thin film for reflected rays. (10)

(b) What are localized frings? How they are formed in Newton's ring experiment? (5)

946

5. (a) Explain the formation of fringes in Michelson's Interferometer. How are these circular fringes different from those obtained in the Newton's Ring experiment? (10)

(b) Explain the determination of difference in wavelength of two waves using Michelson's Interferometer (5)

6. (a) Give the theory of Plane transmission grating and hence deduce the grating equation. Also explain the location of interference maximas and minimas. (10)

(b) Derive an expression for the resolving power of plane transmission grating. (5)

7. (a) Derive Fresenel's integrals and state their properties. (10)

(b) Discuss the theory of zone plate and show that it has multiple foci. (5)

[This question paper contains 2 printed pages.]

Sr. No. of Question Paper : 6145 F-5 Your Roll No.....

Unique Paper Code : 2221303

Name of the Paper : Waves and Optics

Name of the Course : Admitted previously under FYUP

Semester : III

Duration : 3 Hours 07 DEC 2015 Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any five questions in all.
3. Question No. 1 is compulsory.

1. Attempt any five of the following questions.

(a) Distinguish between Group velocity and Phase velocity.

(b) What is the difference between spectra obtained by prism and grating?

(c) What is the advantage of Febry-Perot interferometer over Michelson interferometer.

(d) What are Temporal and Spatial coherence?

(e) How do thin films appear coloured in white light?

(f) Give expression for total energy of a harmonic oscillator over a complete cycle.

(g) A particle vibrates with SHM of amplitude 6 mm. and time period 31.4 seconds. Calculate its maximum velocity. (3×5=15)

2. Derive an expression for the superposition of n-collinear simple harmonic motions with equal frequency difference and hence explain the formation of beats. (8+7)

P.T.O.

3. Obtain the condition of maxima and minima for interference fringes in the thin film due to reflection. Show that the interference pattern of the transmitted system is complementary of the reflected system. (10+5)

4. What is Fresnal's bi-prism? Explain the formation of the interference fringes by Fresnel's bi-prism when a monochromatic source of light is used. Derive an expression for the fringe width. How will you measure the wavelength of a monochromatic light using bi-prism? (2+4+4+5)

5. How are Zone Plates formed? Compare the behavior of a zone plate with that of a convex lens. Use the concept of half period zone to discuss the Fresnel diffraction due to a thin wire. (4+4+7)

6. (a) Discuss the Fraunhofer diffraction of a single slit can be extended to the case of double slit. Compare the diffraction patterns obtained in the two cases. Explain the significance of missing orders in double slit pattern. (4+2+3)

(b) What do you mean by limit of resolution and resolving power of an optical instrument? Derive an expression for the resolving power of a telescope. (2+4)

7. (a) Give the theory of plane transmission grating and hence discuss the intensity distribution in the diffraction pattern. (12)

(b) Calculate the minimum numbers of line in a grating which will just resolve the Na lines in the first order spectra. The wavelengths are 5890Å and 5896Å. (3)

8. Write short notes on any two of the following:

(a) Beats

(b) Lloyd's mirror

(c) Normal modes and Normal co-ordinates of vibrations

(d) Fresnel's Integrals and their uses. (7.5×2=15)

[This question paper contains 5 printed pages.] 13 MAY 2016

Sr. No. of Question Paper : 5777 F **Your Roll No.....**

Unique Paper Code : 222202

Name of the Paper : Oscillations and Waves (PHHT-204)

Name of the Course : **B.Sc. (Hons.) Physics**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all including **Q.No.1** which is compulsory.

1. Attempt any five of the following: 5×3=15

(a) What do you mean by a system having two degrees of freedom? Give two examples.

(b) What are travelling waves? How are they different from stationary waves?

(c) A point mass is subjected to two simultaneous sinusoidal displacement in the x-direction

$$x_1 = A\sin\omega t \;\&x_2 = A\sin\left(\omega t + \frac{2\pi}{3}\right)$$

Adding a third sinusoidal displacement in the same direction

$$x_3 = B\sin(\omega t + \varphi)$$

brings the mass to complete rest. Find the values of $B\&\varphi$.

(d) Waves passing through a plasma like medium have a dispersion relation of the form

$$\omega(k) = \sqrt{\omega_0^2 - \alpha^2 k^2}$$

Find the phase and the group velocity.

(e) What are normal modes and normal coordinates? What is their significance?

(f) Find the equivalent spring constant for the system shown in fig(i) and fig(ii) where identical massless springs are in parallel and series respectively.

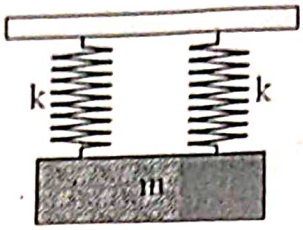


fig (i)

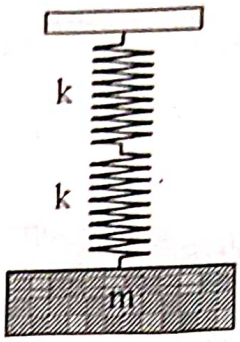


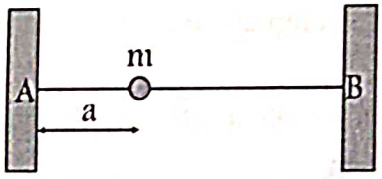
fig (ii)

(g) A heavy object placed on a shock absorber compress it by 1 cm. If the object is given a vertical tap, it oscillates. Compute the frequency of oscillations (neglect damping).

(h) A spherical resonator with a nose of length 4 cm and area of cross section $4\pi^2 cm^2$ responds sharply to a note of frequency 112 cps. If the velocity of sound in air is 336 m/s, what is the volume of the resonator?

2. (a) A mass m is attached to two identical massless springs each of spring constant k. Obtain the expression for the frequency of transverse oscillations usingsmall oscillation approximation. Also derive the expression for frequency of longitudinal oscillations of the system and hence show that the frequency of small amplitude transverse oscillations is same as that of longitudinal oscillations if slinky approximation is valid. 10

(b) A string of length L is stretched with tension T between two fixed points A and B as shown.



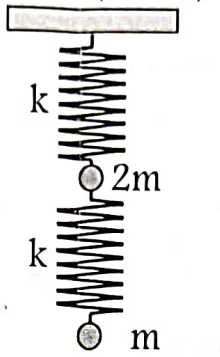
A mass m fixed at a distance a from the point A. Determine the frequency of the vertical oscillations of the mass, assuming that the tension remains constant for small displacements. 5

3. (a) Graphically construct the Lissajous figure for the combined motion of two vibrations at right angles described by the equations

$$x(t) = 10\sin(5\pi t)\ \&\ \ y(t) = 10\sin\left(10\pi t + \frac{\pi}{2}\right)$$ 10

(b) Two masses $2m\ \&\ m$ are connected with two identical massless springs of spring constant k (as shown in the figure below). Show that angular frequency of the two normal modes of vertical oscillations are given by

$$\omega^2 = \frac{k}{m}\left(1 \pm \sqrt{\frac{1}{2}}\right)$$

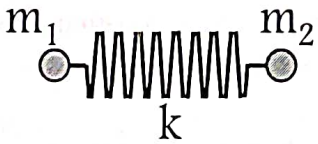


5

4. (a) A particle is subjected simultaneously to N simple harmonic oscillations having frequencies distributed uniformly between ν_1 and $\nu_2$with $\nu_2 > \nu_1$. If the amplitude of each oscillation is a, 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

$$x(t) = a\frac{sin(\pi N\delta\nu t)}{sin(\pi\delta\nu t)}cos[\pi(\nu_2 + \nu_1)t]$$ 10

(b) Two masses $m_1 \& m_2$ are connected by a massless spring of spring constant k as shown.



Show that the system oscillates with a frequency

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}}$$

whereμ is the reduced mass of the system. 5

3. (a) Graphically construct the Lissajous figure for the combined motion of two vibrations at right angles described by the equations

$$x(t) = 10\sin(5\pi t)\ \&\ \ y(t) = 10\sin\left(10\pi t + \frac{\pi}{2}\right)$$ 10

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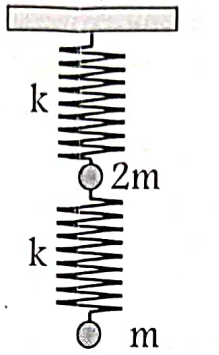
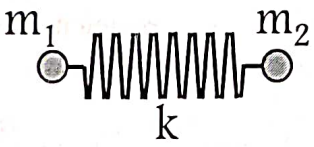


5

4. (a) A particle is subjected simultaneously to N simple harmonic oscillations having frequencies distributed uniformly between ν_1 and $\nu_2$with $\nu_2 > \nu_1$. If the amplitude of each oscillation is a, 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

$$x(t) = a\frac{sin(\pi N\delta\nu t)}{sin(\pi\delta\nu t)}cos[\pi(\nu_2 + \nu_1)t]$$ 10

(b) Two masses $m_1\&m_2$ are connected by a massless spring of spring constant k as shown.



Show that the system oscillates with a frequency

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}}$$

whereμ is the reduced mass of the system. 5

5. (a) Establish the equation of motion of a damped harmonic oscillator of mass m subjected to a periodic force of frequency ω and amplitude F_0. Prove that under steady state the system oscillates with the frequency of the periodic force, and show that the resultant amplitude is

$$A(\omega) = \frac{\frac{F_0}{m}}{\sqrt{(\omega_0{}^2 - \omega^2)^2 + \omega^2\gamma^2}}$$

and the resonant frequency is

$$\omega_R = \sqrt{\omega_0{}^2 - \frac{\gamma^2}{2}}$$

Discuss how the amplitude changes with the frequency of the periodic force and passes through its resonance value. Given ω_0 is the natural undamped frequency, b is the damping coefficient and $\gamma = b/m$. 10

(b) Given that the average power delivered to the oscillator is

$$\langle P(\omega)\rangle = \frac{F_0{}^2\gamma}{2m}\frac{\omega^2}{[(\omega_0{}^2 - \omega^2)^2 + \omega^2\gamma^2]}$$

Derive the expression for the Bandwidth and the Quality Factor. 5

6. (a) Derive the Newton's formula for velocity of sound waves in a gaseous medium having pressure $P$and density ρ_0.How did Laplace modify this formula to arrive at the correct expression given by

$$v = \sqrt{\frac{\gamma P}{\rho_0}}$$

whereγ is the adiabatic constant of the gas. 12

(b) Discuss the variation of sound velocity with temperature and pressure. 3

7. (a) A string of length L and mass density μ is bound at its ends. Starting from the classical wave equation show that the displacement at position x at any time t is

$$y(x,t) = \sum_{n=1}^{\infty} sin\left(\frac{n\pi x}{L}\right)\left[A_n\, cos\left(\frac{n\pi vt}{L}\right) + B_n\, sin\left(\frac{n\pi vt}{L}\right)\right]$$

where$v$ is the wave speed. Also show that if the initial displacements and velocities are known then

$$A_n = \frac{2}{L}\int_0^L y(x,0)\, sin\left(\frac{n\pi x}{L}\right) dx$$

$$\&B_n = \frac{2}{L}\left(\frac{L}{n\pi v}\right)\int_0^L v(x,0)\, sin\left(\frac{n\pi x}{L}\right) dx$$

10

(b) A string of length L is slightly stretched with tension T between its two ends fixed at $x = 0$and $x = L$. A hammer blow is given to a small part of length b at a distance a from the end $x = 0$, as a result of which the part b has an initial velocity v_0 with the rest of the string remaining undisturbed. Show that the subsequent vibration of the string is given by

$$y(x,t) = \frac{4v_0L}{\pi^2 v}\sum_{n=1}^{\infty}\frac{1}{n^2}sin\left(\frac{n\pi a}{L}\right)sin\left(\frac{n\pi b}{2L}\right)sin\left(\frac{n\pi x}{L}\right)sin\left(\frac{n\pi vt}{L}\right)$$

where v is the wave speed. 5

8. (a) Discuss the formation of standing waves in the Melde's experiment. Describe the transverse and longitudinal arrangement of Melde's experiment to demonstrate standing waves. How will you determine the frequency of the tuning fork in each arrangement? 10

(b) In transverse arrangement of Melde's experiment, a string vibrates in four segments when the tension in the string is $0.5\,N$. How much tension is required to make the same string vibrate in one segment in the longitudinal mode? 5

his question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

No. of Question Paper : 6586

nique Paper Code : 32221202 FC-2

ame of the Paper : Waves and Optics

ame of the Course : B.Sc.(Hons.) Physics

17 MAY 2016

emester : II

uration : 3 Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Q. No. 1 is compulsory.

Attempt any *five* of the following :

(*a*) Find the first overtone and second overtone frequencies of an open organ pipe of length 20 cm. [speed of sound in air is 340 m/sec]

(*b*) Transverse waves are generated in two uniform steel wires of diameter 0.1 cm and 0.05 cm respectively. Find the ratio of wavelengths if they are stretched with the same tension. The frequency of source is 500 Hz.

(*c*) How many Fresnel's half period zones will be obstructed by a sphere of radius 1 mm, if the screen is 20 cm away ? Wavelength of light is 5×10^{-5} cm.

P.T.O.

(*d*) Write *three* differences between travelling and stationary waves.

(*e*) Why interference fringes obtained in Fabry Parot Interferometer are sharper than t of Michelson's Interferometer ?

(*f*) Distinguish between 'Division of wavefront' and 'Division of amplitude'.

(g) Define temporal and spatial coherence. 5×3=

2. (*a*) Construct the Lissajous figure for the following :

$$x = \cos(\omega t) \quad \text{and} \quad y = \sin(2\omega t) .$$

(*b*) Two harmonic oscillations of amplitudes A and B having frequencies ω_1 and ω_2 w zero initial phase are superposed. Discuss the resulting motion and give one applica of the phenomenon involved.

(*c*) A wave group is formed by superposition of two waves of slightly different wavelen 0.98 cm and 1.02 cm. What is the difference between two successive crests of group ?

3. (*a*) Derive the differential equation of motion for the transverse vibration of a uniform flexi stretched string.

(*b*) Obtain an expression for the frequencies of the normal modes of the string which is rigi fixed at the ends $x = 0$ and $x = L$.

(*c*) Obtain the relation :

$$(1/v_g) = (1/v) + [(\omega/c)(dn/d\omega)]$$

where v_g is group velocity; v is phase velocity and n is the refractive index of the medium. 4

4. (*a*) Discuss the theory of formation of Newton's Rings. Give the reasons for circular fringes observed. 5,2

(*b*) Calculate the wavelength of light used if diameter of 3rd ring and 13th ring are 0.334 cm and 0.570 cm respectively. Given the radius of curvature of lens is 150 cm. 5

(*c*) Discuss the basic conditions for interference of light to take place. 3

5. (*a*) Obtain an expression for intensity distribution for Fraunhoffer diffraction in case of double slit. 10

(*b*) A diffraction grating used at normal incidence gives a green line of wavelength 5400 Å in a certain order. If the angle of diffraction is 30°, how many lines are there per centimetre of grating ? 5

6. (*a*) Explain the formation of interference fringes in case of Michelson interferometer. How can we use this experiment to find the difference in wavelength of two close spectral lines ? 5,5

(*b*) In the Young's double hole experiment a thin mica sheet of refractive index 1.5 is introduced in the path of one of the beams. If the central fringe gets shifted by 0.2 cm, calculate the thickness of the mica sheet. Assume d = 0.1 cm and D = 50 cm. 5

7. (*a*) Derive Fresnel's integrals. 10

(*b*) A strong parallel beam of monochromatic light is incident normally on a thin plate having a circular hole of diameter 1 mm. If the screen is moved through a distance of 12.5 cm from the first position where the centre is black to a second similar position, find the wavelength of light used. 5

[This question paper contains 2 printed pages.] 12 MAY 2016

Sr. No. of Question Paper : 5783 F Your Roll No.....

Unique Paper Code : 222402

Name of the Paper : Optics (PHHT-412)

Name of the Course : B.Sc. (Hons.) Physics

Semester : IV

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **Five** questions.
3. Question No. **1** is compulsory.
4. Use of non-programmable scientific calculator is allowed.

1. Attempt any *five* of the following questions: 5 x 3 = 15

   (i) Derive the equation $\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2$ from Fermat's Principle of extreme path.

   (ii) Give any three differences between temporal and spatial coherence.

   (iii) What conditions must be satisfied if two beams of light are to give visible interference fringes?

   (iv) Explain why a thin film of oil floating on water appears coloured.

   (v) A very thin film appears to be black when illuminated by white light. Explain why?

   (vi) State the principle of reversibility of light. Write down the two Stoke's relations for reflection and refraction of light at a dielectric interface.

   (vii) Two gratings have the same grating element but different widths of the ruled surface. Which of the two has a higher dispersive power and which has a higher resolving power?

2. (a) Derive an expression for the focal length of a thick convex lens of radii of curvature R_1 and R_2 and thickness t placed in air and for an extended object placed at infinity and located on the principal axis of the lens. 6

   (b) Calculate the cardinal points of a thick biconvex lens placed in air, whose faces have radii of curvature 5 cm and 4 cm, the thickness of lens being 3 cm and refractive index of its material being 1.5. 6

P.T.O

(c) Draw a diagram showing the location of the cardinal points for the above biconvex lens. 3

3. (a) Describe briefly the Fresnel biprism experiment for producing interference fringes in a distant plane. 10
(b) Fringes 0.010 cm apart are formed by a small bi-prism placed 28.7 cm in front of a narrow slit illuminated by monochromatic light. If the screen on which fringes are formed is 71.3 cm from the bi-prism and the refracting angle of each half of the bi-prism is 1^0, calculate the wavelength of light. 5

4. (a) Describe the construction and principle of Michelson Interferometer. 7
(b) Explain the procedure for determining the wavelength separation of D-lines of sodium using the above interferometer. 4
(c) A thin wedge shaped film is illuminated normally by light from a sodium lamp, it appears to be crossed by bright bands with spacing 1.20 mm. Calculate the angle of the wedge in minutes of arc. 4

5. (a) A parallel beam of monochromatic light is incident on N rectangular slits. Starting from the expression for intensity distribution of resulting Fraunhoffer diffraction pattern, find the conditions for maxima and minima for both diffraction and interference. 10
(b) What are missing orders of a grating spectra? Sodium doublet (5890 Å, 5896 Å) when viewed in the third order at 30^0 to the normal is just resolved. Find the grating element and total width of the grating. 5

6. (a) State and explain the properties of Cornu's spiral. 8
(b) Explain the Fresnel diffraction pattern due to a thin wire using Cornu's spiral. How does the intensity distribution change when the thickness of the wire is increased. 5, 2

7. (a) Discuss the Fresnel diffraction pattern due to a straight edge using Fresnel's theory of Half Period Zones. 6
(b) Describe the steps involved in the recording of Hologram. Draw a labelled diagram for the same. 4
(c) An object is placed at 20 cm from a zone plate and the brightest image is situated at 20 cm from the zone plate for a light of wavelength $\lambda = 4000$ Å. Find the focal length of the equivalent lens. Also find the third focal length of the zone plate. 5

This question paper contains 2 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper : 2604

GC-3

Unique Paper Code : 32225310

Name of Paper : Waves and Optics

Name of Course : Other than B.Sc. (Hons.) Physics (Generic Elective) (CBCS)

Semester : III

Duration : : 3 hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all. Q. No. 1 is compulsory. All questions carry equal marks.

1. Attempt any five of the following:

   (a) Show that superposition principle is true only in case of homogeneous linear equations.
   (b) What are beats? Give the necessary conditions for obtaining beats.
   (c) What are stationary waves? How are they formed?
   (d) Which experiment demonstrates that when a ray of light is reflected at the surface of an optically denser medium, it suffers a phase change of π? Explain briefly.
   (e) Distinguish between 'Fizeau' and 'Haidinger' fringes. Give examples.
   (f) Why does an exceedingly thin film appear to be perfectly black when seen by reflected light?
   (g) In a Michelson's interferometer, a shift of 50 fringes takes place in the field of view when the movable mirror is moved through 0.0148 mm.Calculate the wavelength of light used.

3X5

2. (a) What are Lissajous figures?
   (b) Obtain analytically the shape of Lissajous figures traced out by a particle subjected to two perpendicular simple harmonic motions of equal frequencies and unequal amplitudes and phases differing by (i) zero (ii) $\pi/2$ and (iii) π.

2,13

3. (a) Derive the one-dimensional classical wave equation.
   (b) Obtain the expressions for group and phase velocity in case of superposition of waves.
   (c) Derive the relation between phase and group velocities for a dispersive medium.

7, 5, 3

P. T. O.

4. (a) Give Stoke's treatment of reflection and refraction.
   (b) Discuss interference phenomenon in wedge-shaped film.

7½, 7½

5. (a) Explain the formation of Newton's rings and derive an expression for the diameter of dark rings formed by reflected light.
   (b) Newton's rings are observed in reflected light of wavelength 5900Å. The diameter of the 10^{th} dark ring is 0.5 cm. Find the radius of curvature of the lens.

10, 5

6. (a) A parallel beam of monochromatic light is incident normally on a plane diffraction grating. Obtain an expression for the intensity distribution and draw the intensity pattern.
   (b) How many orders of diffraction will be visible in a plane transmission grating having 18000 lines in an inch (2.54cm) when illuminated normally by light of wavelength 6800Å?

10, 5

7. (a) What is a zone plate? Explain how a zone plate acts like a converging lens having multiple foci.
   (b) What are the similarities and dissimilarities between a zone plate and a converging lens?

10, 5

8. (a) What are the conditions to achieve good acoustics of rooms?
   (b) How is polarized light obtained by reflection? Explain briefly and state the Brewster's law.

5, 10

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5058 H

Unique Paper Code : 222363

Name of the Paper : PHPT-303 : Waves and Optics

Name of the Course : B.Sc. Physical Science

Semester : III

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any five questions.

1. (a) Describe Lissajous Figures. (3)

(b) Represent graphically the form of the Lissajous Figure traced out by a particle subjected to two perpendicular simple harmonic motions of unequal amplitudes, frequencies in the ratio 1:2 and phases differing by (i) 0 and (ii) n/4 respectively. (12)

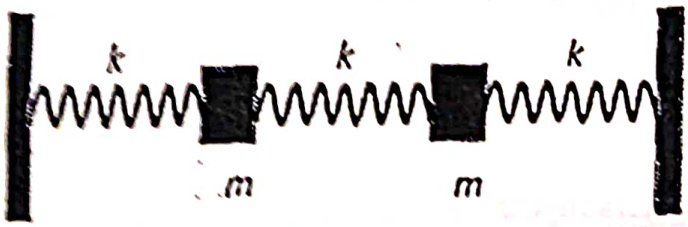
P.T.O.

2. (a) Establish the equation of motion limit of a dam harmonic oscillator. If the damping is less than criti show that the motion of the system is oscillatory w its amplitude decaying exponentially with time.

(b) Define and write an expression for logarithm decrement, relaxation time and quality factor of a wea damped oscillator.

3. (a) What are normal coordinates and normal modes? Expla their significance.

(b) Find the normal mode frequencies and normal mo shapes of the following system executing longitudin vibrations.



4. (a) Using the principle of superposition, derive th expression for standing waves formed in a string length L bounded at the two ends. Also write th expression for normal mode frequencies of the mod and draw the shapes of first two normal modes.

(b) What are stationary waves? Why are they called so? (3)

(a) Explain the formation of Newton's rings and derive an expression for the diameter of dark rings formed by reflected light. (10)

(b) In a Newton's ring experiment, the diameter of the 10^{th} ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid. (5)

(a) Discuss the intensity distribution of Fraunhofer diffraction pattern obtained with a narrow slit illuminated by a parallel beam of monochromatic light. (10)

(b) Light of wavelength 6000A° is incident on a slit of width 0.30 mm. The screen is placed at a distance of 2 m from the slit. Find the distance between the first minima and the central maximum. (5)

(a) Explain the construction and working of a zone plate. Derive an expression for the focal length of a zone plate. Explain how it acts as a converging lens having multiple foci. (12)

(b) What are the similarities and dissimilarities between a zone plate and a converging lens? (3)

8. (a) Explain Rayleigh's criterion of resolution of wavel

(b) Derive an expression for resolving power grating.

(c) What is double refraction and how is it used to polarised light?

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **7474** **HC**

Unique Paper Code : 32225310

Name of the Course : **Physics : Generic Elective for Honours**

Name of the Paper : Waves and Optics

Semester : III

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt any **FIVE** questions in **all.**

(c) Question **No.1** is compulsory.

1. Attempt any **five** of the following : 3×5=15

(a) Define simple harmonic motion. Give examples.

(b) What is the difference between travelling and stationary wave ?

P.T.O.

(c) Differentiate between intensity and loudness of sound waves.

(d) Explain Stoke's treatment of reflection and refraction.

(e) What is the role of compensating plate in Michelson's interferometer ?

(f) Distinguish between Fresnel and Fraunhoffer classes of diffraction.

(g) How many orders will be visible if the wavelength of incident radiation is 5000 $\overset{0}{A}$ and the number of lines in a plane diffraction grating are 2620 per inch (1inch=2.54 cm) ?

2. (a) 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 (i) zero and (ii) $\pi/4$ 10

(b) A turning fork A of frequency 380 Hz gives 5 beats per second when sounded with another turning fork B. On loading B with a little wax, the number of beats per second becomes 3. What is the frequency of B ? 5

3. (a) Explain the formation of standing waves on a stretched string by giving necessary theory. 10

(b) A string of length L is fixed on its two ends. Discuss and obtain different harmonics. 5

4. (a) Explain the Fresnel biprism experiment and derive the conditions for maxima and minima of intensity for a biprism. 10

(b) How is the separation between the two virtual sources determined in this experiment ? 5

5. (a) Differentiate between division of wavefront and division of amplitude methods for producing interference fringes. 3

(b) How can Michelson's interferometer be used to determine the difference between two close wavelengths ? 8

(c) Calculate the distance between two successive positions of the movable mirror of Michelson's interferometer giving rise to distinct fringes in case of sodium lines having wavelength $5890\,\mathring{A}$ and $5896\,\mathring{A}$. 4

6. (a) Derive and discuss the intensity distribution of Fraunhoffer diffraction pattern obtained with a narrow single slit illuminated by a parallel beam of monochromatic light. 10

(b) Light of wavelenght 6000A' is incident on a slit of width 0.30 mm. The screen is placed a distance of 2m from the slit. Find the distance between the first minima and the central maximum. 5

7. (a) Explain Fresnel's division of a cylindrical wavefront into half period zones. 5

(b) How is the diffraction pattern due to straight edge explained in terms of Fresnel division of a wavefront into half period elements. 10

8. (a) What is double refraction ? Define ordinary ray and extraordinary ray. 5

(b) What is Nicol prism and how is it used to produce polarized light ? 10

This question paper contains 4+2 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 861

Unique Paper Code : 222202 G

Name of the Paper : Oscillations and Waves

Name of the Course : B.Sc. (Hons.) Physics

Semester : II

Duration : 3 Hours Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Q. No. 1 is compulsory.

Non-programmable calculators are allowed.

1. Attempt any *five* of the following :

(*a*) A wave of frequency 20 Hz, has velocity 120 m/sec. How far apart are two points whose displacements are 60 degree out of phase.

P.T.O.

(*b*) An object of mass 1 g is hung from a spring and set in oscillatory motion. At $t = 0$ the displacement is 43.78 cm and the acceleration is -1.75 cm/sec^2. Find the spring constant.

(*c*) Distinguish between particle velocity and wave velocity. Write an expression for maximum particle velocity.

(*d*) Show that two superimposed waves of same frequency and amplitude travelling in the same direction cannot give rise to a standing wave.

(*e*) A string of length 0.4 m has a mass of 0.16 gm. If the tension in the string is 70 N, what are the three lowest frequencies it produces when plucked ?

(*f*) Write the equation of displacement of a plane progressive wave.

(*g*) Write *two* differences between stationary and progressive waves. 5×3=15

2. (*a*) Draw Lissajous figure for the combined motion of the following :

$x = \cos(2\omega t)$ and $y = \cos(\omega t + \pi/4)$. 6

(*b*) A uniform string of force constant k and mass m is loaded with mass M. Find the period of vertical oscillation of the system, if m is not negligible as compared to M. 9

3. (*a*) N harmonic oscillations, all of same amplitude and frequency and with equal successive initial phase difference are super posed. Find the amplitude and phase of resultant motion. 10

(*b*) A load of mass 0.5 kg hangs from a string of force constant 10 N/m. The mass is pulled down 0.05 m from its equilibrium position and then released. Find :

(*i*) The distance between two widely separated positions of the masses.

(*ii*) How long does it take to traverse that distance ? 5

4. (*a*) A mechanical harmonic oscillator of mass '*m*' and stiffness constant 'K' is subjected to a viscous damping force that is proportional to its velocity with coefficient of damping force '*p*'. The oscillator is driven by a force F(*t*), such that :

$$F(t) = F_0 \cos \omega t$$

In steady state, the displacement of the oscillator is given by :

$$\Psi = A \cos \omega t$$

Show that, in steady state, the time averaged input power equals the time averaged power dissipated through friction. 12

(*b*) What are the half power points for the power resonance curve for a driven oscillator ? 3

5. (*a*) Two equal masses '*m*' are connected by three identical massless springs of spring constant *k*. The free ends of the springs are rigidly fixed. Find the frequencies and configurations of the two normal modes if the masses oscillate along the line joining the centres of the masses. 10

(*b*) Prove that the principle of superposition holds only for linear homogeneous differential equations. 5

6. (*a*) What is the difference between group velocity and phase velocity ? 5

(*b*) Set up the differential equation for damped harmonic oscillator and solve it for the case of underdamped oscillations. 10

7. (*a*) For one-dimensional plain wave in a fluid, show that the excess pressure p is given by $p = -k\left(\frac{dy}{dx}\right)$, where k is the volume elasticity of the fluid and $y = y(x, t)$ is the displacement. 8

(*b*) Derive a formula for velocity of transverse waves in a string. 7

[This question paper contains 4 printed pages]

Your Roll No.	: .....
Sl. No. of Q. Paper	: **1828** **GC-4**
Unique Paper Code	: 32221202
Name of the Course	: **B.Sc.(Hons.) Physics**
Name of the Paper	: Waves and Optics
Semester	: II

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt any **Five** questions in **all.**

(c) Question **NO.1** is compulsory.

1. Attempt any **five** of the following :

(a) A uniform rod of length L is nailed to a post, so that two thirds of its length is below the post. Find the period of small oscillation of the rod.

(b) A person normally weighing 60 kg stands on a platform which is oscillating up and down with an amplitude of 10 cm. If a weighing machine on the platform gives person's weight against time, what will be the minimum and maximum readings shown by it ?

P.T.O.

(c) Find the average and beat frequency from the combined motion of the following :

$\sin(10\pi t) + \cos(11\pi t + \pi/4)$

(d) A ball suspended by a thread 2 m long is deflected through an angle of 2 degree and then released. Assuming the subsequent motion to be simple harmonic; calculate the velocity of ball when it passes through the mean position.

(e) Distinguish between Fresnel and Fraunhoffer diffraction.

(f) Write two points of differences between convex lens and zone plate.

(g) In a grating, if width of slit (b) is equal to d (the grating element), show that the diffraction pattern corresponds to a slit of width 2b. 3×5=15

2. (a) Construct Lissajous figure for the following :

$x = A\cos(12\ \pi\ t)$; $y = A\cos(6\pi t + \pi/4)$ 6

(b) A uniform string of length L and linear density μ is stretched with tension T between fixed ends at x = 0 and x = L. Derive an expression for the total energy of vibrating string in the n^{th} mode of vibration. 9

3. (a) Derive the differential equation of motion for the longitudinal vibrations of air. 6

(b) Obtain the frequencies of the normal mode of a pipe of length L open at both ends. 4

(c) A wave group is formed by superposition of two harmonic waves of equal amplitude but slightly different frequencies travelling in the same direction in a dispersive medium. Obtain the expressions for group and phase velocity. 5

4. (a) Explain the formation of fringes in case of a wedge-shaped thin film. Derive the expression for fringe width. 2, 5

(b) Distinguish between Fizeau's and Hadinger's fringes. 4

(c) The orange Krypton line of wavelength 6058 $\overset{0}{A}$ has a coherence length of ~ 20 cm. calculate the line width and spectral purity. 4

5. (a) Describe a Fabry Perot Interfrerometer and obtain the intensity distribution function in transmitted light. 3,7

(b) Give the principle of optical reversibility and derive Stoke's relations. 5

6. (a) Obtain an expression for intensity distribution for Fraunhoffer diffraction in case of N slits. Also give the conditions for maximas and minimas. 8,2

(b) A circular aperture of radius 0.01 cm is placed in front of a convex lens of focal length 25 cm and illuminated by a parallel beam of light of wavelength 5×10^{-5} cm. Calculate the radius of the first dark ring. 5

7. (a) Discuss the properties of Cornu's spiral. Explain the Fresnel' diffraction pattern due to a straight edge using Cornu's spiral. Draw the intensity pattern for the same. 2, 6,2

(b) For light of wavelength 6×10^{-5} cm and radius of first half period zone equal to 0.6 cm, a zone plate brings rays to focus at its brightest point. Find the focal length of equivalent lens. 3

(c) What is a phase reversal zone plate ? 2

his question paper contains 4 printed pages]

Roll No. | | | | | | | | | | | |

No. of Question Paper : 2943

Unique Paper Code : 42224412 GC-4

Name of the Paper : Waves and Optics

Name of the Course : B.Sc. (Prog.)

Semester : IV

Duration : 3 Hours Maximum Marks : 75

Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *Five* questions in all.

Question Number 1 is compulsory.

Attempt any *five* parts from the following :

(*a*) If two simple harmonic motions having angular frequencies 440 radian/sec and 396 radian/sec are superimposed, calculate the time period of beats and the number of beats produced.

(*b*) Explain the physical characteristics that determine quality, pitch and loudness of a musical sound.

P.T.O.

(*c*) Distinguish between Fresnel and Fraunhofer class of diffraction.

(*d*) Explain why the reverberation time is larger for an empty hall than for a crowded hall.

(*e*) Give the statements of Huygen's principle of propagation of wave front.

(*f*) Why do thin films appear coloured in white light ?

(*g*) Why are Newton's rings circular ?

(*h*) How is a zone plate different from a covex lens ? 5×3=15

2. (*a*) Trace graphically or analytically the motion of a particle which is subjected to two perpendicular simple harmonic motions of equal frequencies, different amplitudes and having a phase difference of :

(*i*) $\alpha = 0$

(*ii*) $\alpha = \pi/2$

(*b*) Derive the expression for total energy contained in a simple harmonic motion. 10+5=15

3. (*a*) Explain the formation of standing waves on a stretched string.

(*b*) A string 50 cm long is stretched by a load 25 kg and has a mass of 1.44 gm. Find the frequency of the second harmonic. 10+5=15

4. (*a*) What do you understand by electromagnetic waves ? Show that electromagnetic waves are transverse in nature.

(*b*) If intensity is increased by a factor of 20, then how many decibel is the sound level increased ? 10+5=15

5. (*a*) Show that in Young's double slit experiment, the fringe width is directly proportional to the wavelength of light.

(*b*) In case of Newton's ring experiment, calculate the diameter of ninth bright ring having radius of curvature of plano convex lens 10 cm and wavelength of light λ = 40 nm. 10+5=15

6. (*a*) A zone plate has focal length of 50 cm at a wavelength of 6000 Å. What will be its focal length at a wavelength of 5000 Å ?

(*b*) Explain with the help of diagram the intensity distribution due to Fresnel diffraction at a straight edge. 4+11=15

7. (*a*) Give the necessary theory to derive expression for the intensity distribution pattern in a plane transmission grating.

(*b*) A grating of width 2 inches is ruled with 15000 lines per inch. Find the smallest wavelength separation that can be resolved in second order at a mean wavelength of 5000 Å. 12,3

8. (*a*) Give the difference between Haidinger fringes and Fizeau fringes.

(*b*) Explain how Michelson's interferometer can be used to determine the wavelength of monochromatic light ?

(*c*) Prove that the diameters of dark Newton's rings are proportional to the square roots of natural numbers in reflected mode for normal incidence. 3,6,6

(10)

This question paper contains 4 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper : 6681 HC

Unique Paper Code : 32221202

Name of Paper : Waves and Optics

Name of Course : B.Sc. (Hons.) Physics

Semester : II

Duration : 3 hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all.
Question No. 1 is compulsory.
All questions carry equal marks.

1. Attempt any *five* of the following:

(a) Obtain an expression for the amplitude of the combined motion:

$$\sqrt{2}\sin 8\pi t + 2\sqrt{2}\cos 10\pi t$$

(b) Obtain a relation between particle velocity and wave velocity for a simple harmonic wave.

(c) Using the principle of reversibility, derive Stokes' relations.

(d) State the essential conditions for obtaining a sustained interference pattern.

(e) Give differences between Fresnel's biprism and Lloyd's mirror fringes.

P. T. O.

(f) Distinguish between Fraunhofer and Fresnel diffraction.

(g) A convex lens of focal length 20 cm is placed after a slit of width 0·6 mm. A plane wave of $\lambda=6000$ Å falls normally on the slit. Calculate the separation between the second minima on either side of the principal maxima. $5\times3=15$

2. (a) Using the rotating vector representation obtain the resultant motion of a particle subjected simultaneously to two simple harmonic motions in the same direction having equal amplitudes and equal frequencies. 8

(b) A particle is subjected simultaneously to N simple harmonic motions of the same frequency. If the amplitude of each oscillation is A_0 and ϕ is the phase difference between successive oscillations, show that amplitude A and phase δ of the resultant oscillation are given by:

$$A=A_0\frac{\sin(N\phi/2)}{\sin(\phi/2)} \text{ and } \delta=(N-1)\phi/2$$ 7

3. (a) Two vibrations, at right angles to each other, are described by the equations:

$$x=5\cos 3\pi t$$

$$y=3\cos(3\pi t+\pi)$$

where x and y are expressed in centimeters and t in seconds. Construct the Lissajous figure of the combined motion. 5

(b) Obtain an expression for the total energy transport in a string when transverse waves travel in it. 10

4. (a) Explain using diagrams the formation of Heidinger fringes in thin films. How are they different from Fizeau fringes? 7

(b) Derive an expression for fringe width in Young's double slit experiment. Explain graphically the intensity distribution in the fringe system. 8

5. (a) Derive the formula for the intensity of the fringe system formed in a Fabry-Perot interferometer in transmitted light. 9

(b) Draw the graph of intensity transmitted as a function of phase difference in Fabry-Perot interferometer and hence explain why interference fringes obtained in Fabry-Perot interferometer are sharper than that of Michelson's interferometer. 6

6. (a) Discuss Fraunhofer diffraction due to double slit. Draw the curve indicating distribution of intensity in the diffraction pattern. Find the positions of the maxima and minima. 12

(b) Calculate the aperture of the objective of a telescope which may be used to resolve stars separated by $4{\cdot}88\times10^{-6}$ radian for light of wavelength 6000 Å. 3

7. (a) Derive Fresnel's integrals. 8

(b) Discuss Fresnel diffraction pattern due to a straight edge. 7

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6927 HC

Unique Paper Code : 42224412

Name of the Paper : Waves and Optics

Name of the Course : B.Sc. (Prog.)

Semester : IV

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **FIVE** questions in all.
3. Question Number **1** is compulsory.

1. Attempt any **FIVE** parts from the following :

(a) Calculate the minimum intensity of audibility in watt per sq.cm. for a note of 1000 c.p.s. If the amplitude of vibration is 10^{-9} cm. Assume the density of air = 0.0013 gm/c.c and velocity of sound = 340 m/sec.

P.T.O.

(b) If the phase velocity is given by, $v_p = \left(\frac{2\pi S}{\rho\lambda}\right)^{1/2}$ (Here, S and ρ are constant), then find the expression of group velocity.

(c) Give three differences between travelling waves and stationary waves.

(d) What is meant by the term reverberation?

(e) What do you understand by wave front?

(f) Name one experiment each, which is based on division of wave front and division of amplitude.

(g) What is the highest order spectrum which may be seen with monochromatic light of wavelength 5000 A° by means of diffraction grating with 5000 lines/cm.

(h) Write two conditions for observing a sustained interference pattern. (5×3)

2. (a) What are Lissajous Figures? For the cases mentioned below, give the graphical or analytical representation of the Lissajous Figures (with direction) for the motion of a particle which is subjected to two perpendicular simple harmonic motions given by,

$$x = 3\cos(\omega t)$$
$$y = 2\cos(2\omega t + \alpha)$$

Case (i) $\alpha = 0$

Case (ii) $\alpha = \pi/2$

(b) Prove that the principle of superposition holds for linear homogenous differential equation of ruler two.

(10+5)

3. (a) Derive the expression for the differential equation of transverse vibrations of a uniform flexible stretched string fixed at the ends, $x = 0$ and $x = l$. Also find the expression for the velocity of transverse waves.

(b) Draw the shapes of first two modes of a stretched string.

(11,4)

4. (a) Explain plane polarized, circularly polarized and elliptically polarized light? How can we analyze circularly polarized light?

(b) Derive an expression for the intensity of sound wave travelling in still air.

(10,5)

5. (a) Describe briefly the construction of Michelson's interferometer. How it can be used to measure the (i) wavelength of a monochromatic light and (ii) refractive index of a thin transparent sheet.

(b) Show the formation of interference fringes due to Fresnel's biprism with the help of diagram. (12,3)

6. (a) Derive the expression for intensity distribution in case of Fraunhofer diffraction due to single slit.

(b) Find the positions of secondary minima and secondary maxima. (10,5)

7. What is zone plate and how is it made? Explain how a zone plate acts like a convergent lens having multiple foci. Derive an expression for its focal length. (15)

8. (a) Derive the expression for diameter of the Newton's ring pattern for reflected mode. How would you use Newton's rings to measure the wavelength of light?

(b) In Newton's ring experiment, the diameter of 10^{th} bright ring changes from 1.50 cm to1.25 cm when a liquid is introduced between the plate and the lens. Calculate the refractive index of the liquid. (12,3)

[This question paper contains 3 printed pages.]

Your Roll No.....

HC

Sr. No. of Question Paper : 8753

Unique Paper Code : 32223908

Name of the Paper : Applied Optics

Name of the Course : B.Sc. (Prog.) Physics – SEC

Semester : VI

Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all.
3. **All** questions carry equal marks.

1. (a) What is the difference between spontaneous and stimulated emission of radiation?

   (b) What is the difference between holography and photography?

   (c) What role does optical pumping play in lasing action?

P.T.O.

(d) What is the significance of coherence in holography?

(e) What is acceptance cone in optical fibers? (2×5)

2. (a) Derive Einstein coefficients and thereby prove the relation $\frac{A_{21}}{B_{21}} = e^{h\upsilon/kT} - 1$. (7)

(b) Find the intensity of a laser beam of 1 mW power and having a diameter of 1.4 mm. Assume the intensity to be uniform across the beam. (3)

3. (a) Explain the principle of holography with the help of diagrams. (7)

(b) What is a reflection hologram? Explain with the help of a diagram. (3)

4. (a) Explain with diagram the propagation mechanism in an optical fiber. Explain various types of signal losses in fiber communication. (3+4)

(b) Compute the numerical aperture and acceptance angle of an optical fiber with μ_1 (Core) = 1.48 and μ_2 (Cladding) = 1.46. (3)

5. (a) A 15 km optical fiber line uses fiber with loss of 1.5 dB/km. The fiber is jointed every kilometer with connectors which give an attenuation of 0.8 dB each. Determine the minimum mean optical power which must be launched into the fiber in order to maintain a mean optical power level of 0.3 mW at the detector. (7)

(b) How can we reduce the number of modes in an optical fiber? (3)

6. (a) Discuss the working of three level laser in details with the help of diagrams. (7)

(b) How is laser different from ordinary light? (3)

7. (a) Write short notes on : (2½×2)

(i) Low Pass Filter

(ii) Band Pass Filter

(b) Explain how a convex lens works as a Fourier Transformer. (5)

This question paper contains 4 printed pages.]

Your Roll No.....

r. No. of Question Paper : 1033 **I**

Unique Paper Code : 32225310

Name of the Paper : Waves and Optics

Name of the Course : **Physics – GE for Honours**

Semester : III

Duration : 3 Hours Maximum Marks : 75

nstructions for Candidates

. Write your Roll No. on the top immediately on receipt of this question paper.

. Attempt **five** questions in all. Question No. **1** is compulsory.

. **All** questions carry equal marks.

. Attempt any **five** of the following questions : (5×3=15)

(a) State essential conditions for obtaining sustained interference pattern.

(b) What are beats? How are they formed?

(c) Distinguish between "Fizeau" and "Haidinger" Fringes? Give examples.

P.T.O.

(d) State and explain Huygens Principle of secondary waves.

(e) Distinguish between Fraunhofer and Fresnels' diffraction.

(f) How is a zone plate different from convex lens?

(g) Calculate the change in intensity level when the intensity of sound increases 100 times its original intensity. (3)

2. (a) What are Lissajous figures?

(b) Obtain analytically the shape of Lissajous figures traced out by a particle subjected to two perpendicular simple harmonic motions of equal frequencies, unequal amplitudes and phase differing by (i) zero, (ii) $\pi/4$, (iii) $\pi/2$, (iv) π. (12)

3. (a) Explain the physical characteristics that determine quality, pitch and loudness of a musical sound. (3)

(b) Explain the formation of standing waves on a stretched string with necessary theory. (12)

4. (a) What are Newton's rings? Give the necessary theory for their formation? (10)

(b) How would you use Newton's rings to measure wavelength of light? (5)

5. (a) Derive an expression for intensity of Fraunhoffer diffraction due to a single slit and discuss the intensity pattern. (12)

(b) A light of wavelength 6000 Å is incident on a slit of width 0.30 mm. The screen is placed at a distance of 2 m from the slit. Find the distance between the central maxima and the first minima. (3)

6. Derive an expression for intensity of Fresnel diffraction due to a straight edge and discuss the intensity distribution. (15)

7. (a) What is a Nicol prism? How is it used to obtain polarized light? (10)

(b) How polarized light is obtained by reflection? State and explain Brewster's law. (5)

8. Write short notes on any **three** of the following : (3×5=15)

(a) Fresnel's Biprism

(b) Stoke's treatment

(c) Michelson's interferometer

(d) Linearity and superposition principle

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **2263** **IC**

Unique Paper Code : 32221202

Name of the Course : **B.Sc. (Hons.) Physics**

Name of the Paper : Waves and Optics

Semester : II

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt any **five** questions in all.

(c) Question **No.1** is compulsory.

1. Answer any **five** of the following questions : 3×5=15

(a) What are Spatial and Temporal coherence ?

(b) A simple progressive wave is expressed by $y = 0.5 \sin (6.28t - 12.56x)$, where y and x are in meters and t is in seconds. Find (i) wavelength, (ii) maximum velocity and (iii) frequency of the wave.

P.T.O.

(c) Give **three** essential conditions to obtain sustained interference.

(d) Write **two** similarities and **two** differences between zone plate and convex lens.

(e) Distinguish between Fizeau's and Haidinger's fringes. Give **one** example of an experiment where each of them can be obtained.

(f) Which order will be missing for a grating having opacity b=2a, where 'a' is the slit width ? Explain.

(g) Draw a labelled ray diagram illustrating the phenomenon of interference due to a Fresnel's bi-prism.

2. (a) Draw graphically the Lissajous figure for the following : 6

$$x = 5\cos\omega t$$

$$y = 10\cos\left(\omega t + \frac{\pi}{3}\right)$$

(b) Two simple harmonic waves expressed by $y_1 = a_1\cos\omega_1 t$ and $y_2 = a_2\cos\omega_2 t$ are superimposed collinearly. How the resulting motion leads to formation of beats ? Also find the beat frequency. 9

3. (a) Derive differential equation of motion for the transverse vibration of a stretched string and establish an expression for the velocity. 6

(b) Obtain an expression for the path difference between two successive reflected rays in the case of a parallel thin film of refractive index μ and thickness t, and hence obtain conditions for bright and dark fringes. 9

4. (a) Explain with suitable diagram the formation of circular rings in Newton's rings experiment. Obtain an expression for the radius of the n^{th} ring and hence show that the rings get closer as their order increases. 9

(b) In Newton's rings experiment, the diameter of 20^{th} ring changes by 0.05 cm when a liquid is introduced between the lens and the plane glass plate. Find the refractive index of the liquid. 3

(c) In a bi-prism experiment, the eye piece is 120 cm apart from the source. The two virtual images of the source are separated by a distance of 0.075 cm. Find the wavelength of the light used if the cross-wire of the eye piece moves through a distance 1.888 cm for 20 fringes. 3

5. (a) What is Cornu's spiral and how it is formed ? Discuss Fresnel's diffraction at a straight edge using the concept of Cornu's spiral. 9

(b) What do you mean by resolving power of an optical instrument ? Obtain an expression for resolving power of a diffraction grating. 6

6. (a) With the help of necessary theory, derive expression for the intensity distribution pattern in Fraunhofer diffraction at double slit. 12

(b) Calculate the radius of the third half period element of a zone plate behaving as a convex lens of focal length 100 cm. The wavelength of light used is 4800 Å. 3

7. (a) Draw a labelled diagram showing interference due to Lloyd's single mirror. Why is the central fringe dark ? 5

(b) Explain the concept of Fresnel's half period elements and show that every zone has approximately the same area. 7

(c) Draw the intensity pattern for Fresnel's diffraction due to thin and thick wire, mentioning the difference between them. 3

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 2347 **IC**

Unique Paper Code : 42224412

Name of the Paper : Wave and Optics

Name of the Course : **B.Sc. (Prog.)**

Semester : IV

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Five** questions in all.
3. Question Number **1** is compulsory.

1. Attempt any **five** parts from the following : (5×3=15)

(a) Two narrow parallel slits of 0.5×10^{-8} m apart are illuminated by a monochromatic light of wavelength 5890Å. Calculate the width of the fringes which are obtained on a screen distant 0.5 m from the slit.

(b) Why are Newton's rings circular?

(c) Why there is need of extended source in the interference by division of amplitude.

(d) Find the radius of first half period element on a zone plate behaving like a convex lens of focal length 50 cm. The wavelength of light is 5000Å.

(e) What is the condition for absent spectra in a diffraction grating?

(f) What are sound waves? How can they be produced?

2. (a) What do you understand by Lissajous figure? A Particle is subjected to two perpendicular SHM's simultaneously

$x = A_1\cos(2\omega t + \alpha)$ $y = A_2\cos(\omega t)$

obtain Lissajous figure analytically and graphically if $\alpha = \Pi/2$ and Π.

(b) Define simple harmonic motion (SHM). Show that the differential equation of motion for SHM is linear and homogenous. Hence, prove that the principle of superposition hold for SHM. (9,6)

3. (a) What are beats? What is the necessary conditions to obtain them?

(b) Two vibrations along the same line are described by $x(1) = 0.05 \cos 8\pi t$, $x(2) = 0.03 \cos 10\pi t$, where x is in meters, t in seconds. Obtain the equation describing the resultant motion. Hence find the beat period. (5,10)

4. (a) Explain the formation of standing waves on a stretched String. Sketch first three harmonics.

(b) What are progressive waves? How they differ from standing waves. Derive an expression for displacement in the progressive wave in terms of wavelength and velocity. Prove

$$y(x, t+T) = y(x,t) \qquad (5,10)$$

5. (a) In Fresnel's Biprism experiment with a source of light of wavelength 5890 Å, a thin mica sheet of refractive index 1.6 is placed normally in the path of one of the interfering beams and the central bright fringe is shifted to a position of third bright fringe from the centre. Calculate the thickness of the mica sheet.

(b) Derive the conditions of constructive and destructive interference for Young's double slit experiment. (10,5)

6. (a) Explain the determination of difference in wavelengths of two waves using Michelson's Interferometer. How Michelson's Interferometer can be used to measure the refractive index of a thin transparent sheet.

(b) In an experiment for determining the refractive index of a gas using Michelson's interferometer a shift of 148 fringes is observed, when all the gas is removed from the tube. If wavelength of light used is 589.3 nm and length of the tube is 20 cm, calculate the refractive index of the gas.

(10,5)

7. (a) Each slit of a double slit has a width of 0.15 mm and the distance between their centers is 0.75 mm. Find the missing orders in the diffraction pattern.

(b) Derive an expression for intensity distribution for Fraunhofer diffraction due to double slit.

(5,10)

8. (a) What is zone plate? Show that a zone plate has multiple foci. Compare the zone Plate with a convex lens.

(b) What is polarization of light? Explain elliptical and circular polarization. (10,5)