CC 4 : Waves and Optics

I. One markQuestions.

1. The condition of achromatism and minimum spherical aberration are fully satisfied in :
(a) Ramsden's eyepiece(b) Huygen's eyepiece
(c) both Ramsden's and Huygen's eyepieces(d) neither Ramsden's nor Huygen's eyepiece
2. The Ramsden's eyepiece consists of two plano-convex lens of focal length: (a) f each
(b) different focal lengths
(c) may be both equal or different focal lengths
(d) none of these
3. If focal length of eye lens in Ramsden's eyepiece is f, then separation between two lenses is :
(a) f

(b)(2/3)f
(c) 2f
(d) 3f
4. If the focal length of eye lens of Huygen's eyepiece is f, then focal length of the field lens and separation between two lenses respectively :
(a) 3f, 2f

(b) f, 2/3 f
(c) 2f 3f
(d) 3f, f
5. The equivalent focal length of Huygen's eye piece if focal length of eye lens is fis :
(a) 2/3 f (b) 3/2 f (c) f/3 (d) 2f
6. The equivalent focal length of Ramsden's eye-piece if focal length of one of its lenses is fgiven by
(a)2/3 f (b) ¾ f (c) f (d) 4/3 f

7. Motion of a particle represented by equation
x= A cos (wt + φ) is :
(a) periodic
(b) uniform circular motion
(c) oscillatory
(d) both oscillatory and SHM
8. A particle is subjected to two mutually perpendicular S.H.Ms. such that
x = 2 sin wtandy = 3 sin (wt +$\frac{\pi}{4}$).
The path of the particle will be :
(a) ellipse (b) straight line (c) parabola (d) circle
9. A particle is subjected to two mutually perpendicular S.H.Ms. such that
x = 3 cos wtandy = 4 cos (wt + π)
The path of the particle will be :
(a) ellipse (b) straight line (c) parabola (d) circle
10. The displacement of a particle performing S.H.M. is related to time t as
x = 0.05 cos(4πt+π/4) where x is displacement in meter and t in seconds. The frequency of motion will be :

(a) 1 Hz (b) 2 Hz (c) 0.5 Hz (d) 1.5 Hz

11. In Young's double slit experiment, the angular width of interference fringes is 0.20° for sodium light of wavelength 5890 Å. For what value of wavelength this width will be more than 0.22°?

(a) 6479 A^o
(b) 6581 A^0
(c) 5875 A^0
(d) 7845 A^0

12. Two waves of the same frequency and same intensity are superposed in the same phase. The intensity of the resultant wave at the central point will be

(a) equal to that of incident wave
(b) Twice to that of the incident wave
(c) four times to that of the individual wave
(d) thrice to that of the incident wave

13. If monochromatic light in Young's double slit experiment is replaced by white light then
(a) no fringes are observed
(b) all bright fringes are white
(c) all bright fringes are coloured including central fringe
(d) all bright fringes are coloured but the central fringe is white.

14. In Young's double slit experiment with slit separation d, a monochromatic light of wavelength λ is used. The angular separation of the fringes is
(a) d/λ (b) λ/d (c) 2λ/d (d) λ/2d

15. In Young's double slit experiment the intensity at a point where the path difference is λ/6 is I where λ is the wavelength. Find the phase difference then I/I_0 is equal to

(a) 60^o
(b) 30°
(c) 45°
(d) 0°

16. On reflection from a denser medium, path difference introduced is
(a) zero
(b) λ/2

(c) λ
(d) 2λ

17. A thin film is viewed in white light. The colour of the film seen at a particular point depends upon
(a) width of the source
(b) distance of the source
(c) location of the observer
(d) none of the above

18. In Fresnel biprism, two positions of lens give separtiondy and do between slits as 16 mm and 9 mm respectively. What is the actual separation ?

(a) 12.5 mm
(b) 12 mm
(c) 13 mm
(d) 14 mm

19. In Young's double slit experiment, the slits are 2 mm apart and are illuminated

by photons of wavelengths $\lambda_1 = \underline{12000}$ A^o and $\lambda_2 = \underline{10000}$ Å. At what minimum distance from the common central bright fringe on a screen 2m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other ?

(a) 4 mm

(b) 3 mm
(c) 8 mm
(d) 6 mm

20. In Young's double slit experiment, using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference isIunits. What istheintensity of light at a point on the screen where the path difference is λ/4.
(a) λ/8 (b) λ/4 (c) λ/2 (d) λ

21. Michelson's interferometer was originally designed to test :
(a) the existence of matter on earth (b) the existence of absolute space
(c) the existence of earth itself (d) none of the above
22. In Michelson interferometer, where mirrors M_1 and M_2 are made slightly inclined the fringes obtained are :
(a) straight (b) elliptical (c) circular
(d) inclined
23. Standardisation of a metre by Michelson involved the determination of:
(a) the exact number lines in 1 m span with a cadmium source
(b) materials used in the standard meter
(c) the exact number of wavefronts in 1 m length span with a standard cadmium source
(d) the exact number of wavefronts in 1 m span
24. The wavelength of the orange red light of krypton-86 now has replaced the _____ bar as the world standard of length. Fill in the blank space.
(a) iron
(b) soft iron
(c) galvanised zinc
(d) platinum iridium
25. In Michelson's interferometer, a compensating plate is used for :
(a) to make equal paths between two rays (b) to make equal frequency between the rays (c) to make apparatus sturdy (d) to make apparatus look safe

26. Resolving power and limit of resolution' are :
(a) one and same thing
(b) reciprocal of each other
(c) totally unrelated quantities (d) yet not well defined
27. Fraunhofer's diffraction at a double slit :
(a) is just like that at a single slit (b) involves interference effects also
(c) produce totally different results
(d) is sometimes similar to that at a single slit
28. The intensity distribution in a diffraction pattern is :
(a) uniform throughout
(b) fluctuating
(c) decreasing with increase of distance from central point on the screen
(d) none of these

29. The intensity of principal maximum in the spectrum of grating having N slits is proportional to

(a) 1/N (b) N (c) N^2 (d) $1/N^2$

30. The angle of diffraction for the second order principal maxima for wavelength 5×10^{-5}cm is 30°, in a plane transmission grating. The number of lines in one cm of the grating is :

(a) 10

(b) 100

(C) 1000

(d) 5000

31. A plane transmission grating having 5000 lines/cm is being used under normal incidence of light. The highest order spectrum seen for light λ = 4800 Å is

(a) 1

(b) 2

(C) 3

(d) 4

32. In a grating spectrum, a line in the second order coincides with a line in the third order. If the wavelength of first line is λ, then that of the second line is

(a) λ/2 (b) λ (c) 2λ/3 (d) λ/3

33. In a transmission grating, the transparent and opaque strips are of equal width (i.e. a = b). The absent orders are :

(b) even

(c) all

(d) none

34. In a transmission grating, the width of transparent strips are double of the width of opaque strips (i.e. a = 2b). The absent orders are :

(a) odd

(b) even

(c) all

(d) none

35. In a single slit diffraction experiment if the red colour is replaced by blue, then

(a) the diffraction pattern becomes narrower and crowded together

(b) the diffraction bands become wider

(c) the diffraction pattern does not change

(d) the diffraction pattern disapears

36. The diameter of half period zones are proportional to :

(a) $1/\sqrt{n}$

(b)1/n

(c) $\sqrt{n}$

(d) $1/n^2$

un

37. Area of second half period zone (S_2) and that of the first half period zone (S_1) are related as

(a) $S_2 = 2S_1$ (b) $S_2 = S_1$ (c) $S_2 = 2/S_1$ (d) $S_2 = S_1/2$

38. Cornu's spiral is a :

(a) graphical representation of Fresnel diffraction

(b) method developed only for academic interest

(c) geometrical representation of Fresnel's diffraction

(d) totally funny method for fun games
39. The intensity distribution in a diffraction pattern is :
(a) uniform throughout
(b) fluctuating
(c) strictly decreasing with distance from the central point on the screen
(d) strictly increasing width distance from the central point on the screen.
40. A well known device that is based on the concepts of Fresnel half period zone is:
(a) zone plate
(b) Cornu's spiral
(c) diffraction meter
(d) grating
41. Cornu's spiral method is
(a) a very complex method
(b) only a rough approximation of diffraction effects
(c) used for study of Fraunhofer diffraction
(d) a neat and simpler method for studying Fresnel's diffraction and is based on Fresnel's integrals

II. 1.5 mark questions.

1. What is the basic essentials for the propagation of waves through a medium ?
2. Do you agree that wave velocity is also called phase velocity ? Explain.
3. What is meant by one, two and three dimensional waves ?
4. Derive the relation between wave velocity and particle velocity.
5. Derive a relation between group velocity and phase velocity.
6. Explain how energy is propagated in a progressive wave ? Write an expression for energy density.

7. Why transverse waves are produced only in solid and on the surface of liquid and not inside a liquid or a gas ?
8. Why longitudinal waves are produced in solids, liquids and also in gases?
9. What is the cause of dispersion of sound ?
10. Is group velocity greater than wave velocity ? Explain.
11. What is the difference between dispersive medium and non-dispersive medium?
12. What is the difference between normal dispersion and anomalous dispersion?
13. Do you agree that the total energy and intensity of a progressive wave are independent of space and time co-ordinates ? Explain.
14. Derive a relation between phase difference and path difference.
15. Derive the dispersion relation w = vk, where v is the phase velocity of wave and k is the wave number.
16. Why cannot a sinusoidal wave be used for transmission of a signal ? Explain.
17. Why is a wave packet essential for a transmission of a signal. Give two examples of wave packets.
18. State the dispersion relations for (i) non-dispersive (it) normally dispersive and (iii) anomalously dispersive media.
19. Distinguish between wave velocity and group velocity.
20. Write the differential equation of wave motion
21. Write the classical equation of a wave motion.

22.What is the differential equation of a simple harmonic oscillator ?
23. Write the solution of differential equation of a simple harmonic oscillator.
24. What do you mean by Lissajous figures ?
25. What should be the frequency ratio and phase difference between two rectangular perpendicular simple harmonic motions to obtain the figure '8'?
26. What should be the frequency ratio and phase difference between two rectangular perpendicular simple harmonic motions to obtain a parabola.

27. Can we obtain interference patter if the two coherent sources are separated by less than the wavelength of light. Explain ?
28. Give examples of phenomenon to illustrate the interference by :
(i)division of amplitude and (ii) division of wavefront.
29. Explain the nature of zero order central fringe in the case of Lloyd's single mirror.
30. Distinguish between the interference patterns formed in biprism and single mirror.
31. What are Haidinger Fringes and Fizeau fringes?
32. How does the variation in the interference by reflection in then films differ from that by refraction ?
33. Explain the necessity of broad source of light for observing colours in thin films.
34. State Stoke's law in terms of phase change on reflection ?

35. Can we produce interference with white light ?
36. Do interference effects occur for sound waves ?

37. What is etalon ?
38. Why is diffraction pattern generally not observed with an extended source of light?
39. What are the essential conditions for having Fraunhofer diffraction ?
40. Explain Rayleigh's criterion for a solution.
41. What is meant by resolving power of an instrument ?
42. Define grating element of a diffraction grating.
43. What is the cause of light streaks one sees while looking at a strong source of light with half shut eyes ?
44. Why is the diffraction of sound waves more evident in daily life than that of light waves ?
45. Distinguish between interference and diffraction.
46. What are the main classes of diffraction phenomenon ?
47. What is the difference between the diffraction patterns obtained with single and double slit in case of Fraunhofer's diffraction ?
48. What type of Fraunhofer's diffraction pattern, we get, with a circular aperture ?

49. What is a Fresnel's diffraction ?
50. What assumptions were made by Fresnel to explain the diffraction ?

51. Explain the meaning of Fresnel's half period zones.
52. What are the radii of zones of zone plate ?

53. In what respect a zone plate is similar or differ from a convex lens.

54. What is Cornu's spiral ? Give its significance.
55. Write two Fresnel integrals.
56. What is the difference between positive and negative zone plate.

III. 2.5 mark questions.

1. Given below are some examples of wave motion. State in each case, if the wave motion is transverse, longitudinal or combination of both.
(i) Motion of a kink in long coil string produced by displacing one end of the string side ways.
(ii) Waves produced in a cylinder containing a liquid by moving its position back and forth
(iii) Waves produced by motor boat sailing in water.
(iv) Ultrasonic waves are produced in air by vibrating quartz crystal.
2. What is wavefront and Huygen's principle ? Explain.
3. Explain the term wavefront. Describe Huygen's construction for propagationof wavefronts in a medium.
4.With the help of diagram, explain the Huygen's principle for propagation light in a medium.
5.What are the two assumptions on which Huygen's principle is based ? ExplainHuygen's geometrical construction of wavefronts.
6. Verify laws of reflection using Huygen's wave theory.
7. Describe the phenomena of refraction from Huygen's wave theory.
8. State temporal and spatial coherence.

9. Is sodium light really a coherent souce ? Explain.
10. Distinguish between temporal and spatial coherence.
11. Give the conditions for sustained interference.
12. Where does the energy of bright band come from. Explain.
13. What will happen if the distance between two slits in Young's double slit experiment nearly becomes zero?
14. When a low flying air plane passes overhead, we sometimes notice a slight shaking of the picture on our Television screen. Why?
15. Explain what happens when the width of the slit in Fresnel's biprism is increased?
16. The width of the interference fringes for red light is double than that of the violet light. Why?
17. What changes would occur in the interference pattern when the edges of Fresnel biprism are taken parallel to the slits?

18. What is an interferometer?
19. Under what conditions are circular fringes formed in Michelson's interferometer?
20. What are the applications of Michelson interferometer? List them.
21. How localised fringes are produced in the Michelson interferometer.
22. Explain, why a monochromatic light is used in Michelson's interferometer.
23. List few applications of etalon.
24. How Fabry Perot interferometer is used to determine the difference between two closely situated wavelengths.
25. What are the advantages of Fabry Perot Interferometer over the Michelson interferometer.
26. Explain the finesse of Fabry Perot Interferometers.

27. A plane transmission diffraction grating with 12500 lines is used in second order with a light of 5000 A^o. Calculate the smallest wavelength difference itcan resolve.
28. Obtain the design of a plane transmission diffraction grating capable of resolving a wavelength of $7A^o$ at a mean wavelength of 7000 Å in second

order spectra.
29. A parallel beam of sodium light is allowed to incident normally on a gratinghaving 4250 lines per cm and the second order spectral lines are observed tobe deviated through 30°. Calculate the wavelength of sodium light.
30. How many orders will be visible if the wavelength of incident radiation is 5000 Å and number of lines on the grating is 7620 to an inch?
31. In a grating spectrum, which spectral line in 4th order will overlap with 3rdorder line of 5461 A^{o} ?
32. A plane diffraction grating with 15000 lines is used in the second order witha light of 6000 A^{o}. Calculate the smallest wavelength difference it can resolve.

33. Explain the difference between interferernce and diffraction?

34. Distinguish between Fresnel's and Fraunhofer's diffraction.

35. What are the factors on which the amplitude of light waves from a half period zone at the observation point depends?

36. How will you determine wavelength of light from the study of diffraction at a straight edge?

37. Explain the changes produced in diffraction pattern as the diameter of the wire is increased.

IV. 5 marks Questions

1. What is chromatic aberration? Obtain conditions for achromatism of two thin lanes

(a) When they are in contact
(b) When they are separated

2. Discuss the construction and necessary theory of Ramsden's eyepiece and locate the cardinal points. Compare it with Huygen's eyepiece.

3. Define system matrix and cardinal points of an optical system. Obtain an expression for equivalent focal length of an optical system in terms of system matrix.

4. What is an eyepiece? What are its advantages over single lens? Describe the construction and working of Huygen's eyepiece and locate its cardinal points.

5. What are Newton's rings? Describe an experimental arrangement for observing Newton's ring in reflected light. Derive an expression for radii of bright and dark rings.

6. Describe construction and working of Michelson-interferometer. Under what condition will it give circular fringes?

7. What are gravity waves? Derive an expression for velocity of gravity waves.

8. Distinguish between phase velocity and group velocity Newton's. Find the relation between them.

9. What is plane diffraction grating? Discuss with necessary theory how would you use it for determine wavelength of light.

10. Explain the principle of Fabry-perot interferometer.Obtainan expression for the intensity of transmitted light with the help of interferometer. Explain the visibility of fringes.

11. Discuss Fraunhofer diffraction at a single slit.

12. Discuss Fermat's principle. Use it to prove the laws of reflection of light.

13. Obtain the system matrix for a thin lens and derive the thin lens formulae.

14. State and explain Huygen's principles of secondary wavelets. With the help of this principle, derive an expression for the focal length of a biconcave lens.

15. State and explain Huygen's principles ofwave propagation of light. Explain the laws of reflection and refraction on this basis.

16. What do you mean by a progressive wave? Derive the equation of a progressive wave. Discuss its properties.

17. What are Lissajous figures? Discuss with necessary theory the superposition of two rectangular simple harmonic motions of equal frequencies but different amplitudes in details.

18. Discuss in detail the result of superposition of n harmonic waves.

19. Obtain an expression for fringe width by Young's experiment.

20. Describe the formation of fringes with the help of Fresnel's biprism. Deduce an expression for the fringe width.

21. Distinguish between Haidinger's and Newton's fringes. Discuss the formation and location of interference fringes in a thin wedge-shaped film.