

Fourth Semester B.Sc. Degree Examination, April/May 2019

(CBCS Scheme)

Physics

Paper IV — WAVES, OPTICS AND STATISTICAL PHYSICS

Time : 3 Hours]

[Max. Marks : 90

Instructions to Candidates : Answers should be written completely in English.

PART – A

1. Answer any **FIVE** of the following. Each question carries **8** marks. **(5 × 8 = 40)**
1. (a) State and explain principle of superposition of oscillations.
(b) Derive the expression for the resultant displacement when two harmonic oscillations of equal frequency superimposed and hence deduce the expression for resultant amplitude and phase. **(2 + 6)**
 2. (a) Define group velocity. Derive the expression for group velocity.
(b) Derive the relation between group velocity and phase velocity. **(4 + 4)**
 3. (a) Define reverberation and reverberation time.
(b) Obtain an expression for Sabine's formula. **(2 + 6)**
 4. (a) What is viscosity?
(b) Derive Poiseuille's equation for the flow of a viscous fluid through a narrow tube. **(1 + 7)**
 5. Explain with theory the diffraction due to a straight edge, hence deduce expression for path difference and arrive at an expression for maxima and minima. **(8)**
 6. Explain how circularly and elliptically polarized lights are produced and detected. **(8)**
 7. (a) What are fermions? Give an example.
(b) Obtain Fermi-Dirac distribution law. **(2 + 6)**
 8. (a) Define microstate and macrostate.
(b) Bring out the comparison between Maxwell-Boltzmann statistics, Bose-Einstein statistics and Fermi-Dirac statistics. **(2 + 6)**

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PART – B

- II. Answer any **SIX** of the following. Each question carries **5** marks. **(6 × 5 = 30)**
9. Two tuning forks A and B are of nearly equal frequencies. The frequency of B is 256 Hz. When the two tuning forks are used to obtain Lissajous figures, the complete cycle of changes takes place in 5 seconds. When the tuning fork A is filed, the time taken for one cycle of change is 2 seconds. Calculate the original frequency of A.
10. A sitar wire under tension of 20 N has length of the bridge 70 cm. A 10 m sample of that wire has mass 2.5 gm. Find the speed of the transverse waves on the wire and fundamental frequency.
11. Find the acoustic intensity level at a distance of 6 m from the source that radiates energy at the rate of 5 W. Consider reference intensity as 100 Wm^{-2} .
12. Calculate pressure inside a small air bubble of radius $3 \times 10^{-4} \text{ m}$ situated just below the surface of water. Surface tension of water is $70 \times 10^{-3} \text{ Nm}^{-1}$ and the atmospheric pressure is $1.012 \times 10^5 \text{ Nm}^{-2}$.
13. In Fraunhofer diffraction due to a narrow slit, a screen is placed 4 m away from the lens to obtain the diffraction pattern. If the slit width is 0.2 nm and the first minima lie 6 mm on either side of the central maximum, find the wavelength of light.
14. The radius of the first zone plate of 0.05 m for a source of light of wavelength 541.6 nm which is placed at a distance of 1.8 m from the plate. Calculate
- (a) The focal length of the equivalent lens that has the same effect as that of the given zone plate.
- (b) Position of the image of the source.
15. Calculate the thermo dynamic probability of various macrostates corresponding to distribution of four particles in two compartments.
16. Calculate the Fermi energy of copper at absolute zero temperature given density of copper is $8.96 \times 10^3 \text{ kg m}^{-3}$ atomic weight of copper is 64 and each copper atom contains one free electron. Given Avagadro number $N = 6.023 \times 10^{23}$ atoms/mole $h = 6.625 \times 10^{-34} \text{ JS}$, $m_e = 9.1 \times 10^{-31} \text{ kg}$.

PART – C

III. Answer any **TEN** of the following. Each question carries **2** marks. **(10 × 2 = 20)**

17. (a) If the tension of a string is doubled, how many times the fundamental frequency change?
- (b) How intensity of a wave varies with amplitude and velocity of the wave?
- (c) What are the factors that decides the shape of Lissajous pattern?
- (d) In Helmholtz resonator we hear maximum sound for certain volume of air column. Explain.
- (e) How it is possible for insects to walk on water?
- (f) What is the principle of diffusion pump?
- (g) Why diffraction grating cannot be used to study the diffraction of X-ray?
- (h) Can we distinguish between interference fringes and diffraction fringes? Explain.
- (i) On what factors specific rotation of sugar solution depend.
- (j) How does the occupation number in Maxwell's Boltzmann statistics for a given energy state vary as the temperature.
- (k) What are the features of Bose-Einstein statistics?
- (l) What is the probability of occupation of Fermi level at $T = 0$ K and $T > 0$ K.
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