SE – 151

IV Semester B.Sc. Examination, September 2020
(CBCS – Fresh + Repeaters – 2017-18 and Onwards)
PHYSICS – IV
Optics and Fourier Series

Time : 3 Hours Max. Marks : 70

Instruction : *Non programmable scientific calculators are* ***permitted.***

PART – A

Answer **any five** of the following. **Each** question carries **eight** marks. **(5×8=40)**

1. a) Mention any two features of the Huygen's wave theory of light. 2

   b) What is a wavefront ? Draw wavefront due to a point source in an isotropic medium. 2

   c) Derive the law of reflection for spherical wavefront at a plane surface. 4

2. With relevant theory, explain interference at thin films in the reflected system.

3. Give the theory of Fresnel's half period zones. Hence account for rectilinear propagation of light.

4. a) State Rayleigh criterion and explain the same with suitable diagram. 2

   b) Define resolving power of optical instruments. Derive expression for resolving power of telescope. 6

5. a) What is double refraction ? Distinguish between ordinary ray and extra-ordinary ray in a doubly refracting crystal. 3

   b) With a diagram, describe the construction and working of Laurent's half-shade polarimeter. 5

6. a) In the context of LASER, define the terms population inversion and stimulated emission. 2

   b) Explain the construction and working of Ruby laser. 6

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7. a) State Dirichlet's conditions. **2**

   b) Analyse a square wave using Fourier series. **6**

8. a) Explain the structure of an optical fibre with suitable diagram. **2**

   b) Explain the difference between a step-index fibre and a graded-index fibre. **2**

   c) In an optical fibre, derive expression for the time delay due to inter modal dispersion. **4**

PART – B

Answer **any five** of the following. **Each** question carries **four** marks. **(5×4=20)**

9. In a biprism experiment, a film of thickness 8.8359 micron made of material of refractive index 1.5 is introduced in the path of one of the beams. If the number of fringes shifted at any point is 15, find the wavelength of light used.

10. In a Newton's rings arrangement, the 3rd and 11th dark rings were found to have diameters of 0.4 cm and 0.7 cm respectively. Find the diameter of the 15th dark ring.

11. Fraunhofer diffraction pattern is obtained using light of wavelength 589.3 nm incident on a single slit of width 4.5 mm. When observed on a screen at 50 cm from the slit, find the angular width of the central maxima.

12. In an experiment with diffraction at straight edge, the distance between the slit and the edge is 12 cm and that between the edge and the screen is 1.5 m. If the wavelength of light used is 5893 Å, find the distance between first and third dark bands in the diffraction pattern.

13. A suitably cut quartz plate of thickness 50 μm has refractive indices 1.581 and 1.600 for o-ray and e-ray, respectively. When light of wavelength 546 nm is incident on the crystal, find the path difference and the phase difference between the emergent rays.

14. A lasing system is in thermal equilibrium at 27°C. Find the ratio of population between upper and lower energy states which are separated by 1.2 eV. Given Boltzmann's constant = $1.38 \times 10^{-23} JK^{-1}$.

15. Check whether the following functions are even, odd or neither –

    a) $f(x) = x \sin x$ and b) $f(x) = e^x$

16. Calculate the fractional refractive index and numerical aperture of an optical fibre made of core and cladding of refractive indices 1.504 and 1.469, respectively.

PART – C

Answer **any five** of the following. **Each** question carries **two** marks. **(5×2=10)**

17. a) Does the phenomenon of interference violate the principle of conservation of energy ? Justify.

    b) How can we conclusively prove that light has wave nature ?

    c) When will any wave undergo appreciable diffraction ? Explain.

    d) Can the resolving power of a grating be increased ? Explain.

    e) Can the o-ray and the e-ray in a doubly refracting crystal be easily distinguished ? Explain.

    f) Can a pure Ruby crystal be used for lasing action ? Explain.

    g) A rectangular wave is a combination of sine and cosine functions. Justify.

    h) Is attenuation of signal intrinsic to an optical fibre ? Explain.