

2011

Time : 3 hours

Full Marks : 70

Instructions :

- (i) There are **NINE** questions in the paper. All questions carry equal marks.
- (ii) Attempt **FIVE** questions in all.
- (iii) Question No. 1 is compulsory.

1. Answer any seven questions : $2 \times 7 = 14$

- (a) Evaluate $\vec{\nabla} \times \vec{r}$, where \vec{r} is the position vector. **akubihar.com**
- (b) Evaluate $\vec{\nabla} \cdot \vec{F}$, where $\vec{H} = \vec{r}V$, $V =$ scalar field and \vec{r} is the position vector.
- (c) State Malus law and Brewster's law.
- (d) What are ordinary and extra-ordinary rays? Which of them does not obey Snell's law?
- (e) What happens to the diffraction pattern when the size of the hole or obstacle is
(i) much smaller than the wavelength and (ii) much larger than the wavelength?

- (f) What is the necessity of optical feedback in laser system?
- (g) Explain the negative results of Michelson-Morley experiment.
- (h) What do you mean by expectation value of a physical quantity?
- (i) Why should the wave function be normalized to 1? **akubihar.com**
- (j) What are matter waves? How is wavelength of matter wave related to the properties of particle?

2. (a) Starting from Maxwell's e.m. equations in free space, obtain e.m. wave equations for electric field and magnetic field. Hence obtain the expression for the speed of e.m. wave in vacuum. $6+6$
- (b) The maximum value of electric field in an e.m. wave, in vacuum, is 800 V/m. Find the maximum value of magnetic intensity. 2
3. (a) Explain briefly why four-level laser is better than three-level laser. 3
- (b) Describe the construction and working of He-Ne gas laser. In this laser, why is the proportion of He more? $4+5+2$

4. (a) What is the purpose of conducting Michelson-Morley experiment? Find an expression of fringe-shift in this experiment. 2+8
- (b) How it helps to develop special theory of relativity? 4
5. (a) What do you understand by eigenvalues and eigenfunctions? akubihar.com 4
- (b) Solve the Schrödinger's wave equation for a particle confined to one-dimensional box of side a and obtain its eigenvalues and eigenfunctions. 10
6. (a) What so you mean by temporal coherence? Discuss how coherence length of a source is measured with Michelson's interferometer. 2+8
- (b) Find an expression for line width. 4
7. (a) What are plane polarised, elliptically polarised, circularly polarised and partially polarised light? Explain production and detection of different types of polarised light. 4+3+4
- (b) Calculate angle of polarisation for a transparent surface if the incident beam of light makes an angle of 60° with the surface, the angle of refraction is 13° .
[$\sin 13^\circ = 0.225$] 3

8. (a) What is the significance of secondary maxima in the diffraction pattern due to a single slit? Where are they located? 4+2
- (b) Investigate theoretically the Fraunhofer diffraction pattern due to double slit. 8
9. Write notes on any *two* of the following : 7×2=14
- (a) Failure of Galilean transformation in special relativity
- (b) Davisson-Germer experiment
- (c) Ruby laser
- (d) Poynting vector
