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3 (Sem-6) PHY M 3

2020

## PHYSICS

(Major)

Paper : 6·3

Full Marks : 60

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

**Group - A**

**(Modern Optics)**

Marks : 40

1. Answer the following questions :  $1 \times 4 = 4$

(a) What is CW laser ?

(b) What does the word "holography" mean ?

Contd.

(c) You are going to study radiations of wavelength between  $350\text{ nm}$  and  $200\text{ nm}$  with the help of a prism spectrograph. Name the material of the prism you should use.

(d) Why Huygen's eyepiece cannot be used for measurement purpose?

2. Answer the following questions :

(a) In optical communication system, why infrared is preferred over visible light? 2

(b) Second harmonic generation is not possible with conventional light o. Explain. 2

(c) The field lens of a Huygen's eyepiece is  $12\text{ cm}$ . Calculate the equivalent focal length of the eyepiece. 2

3. Explain how phase matching condition for Second Harmonic Generation can be achieved. 5

**OR**

Calculate the angular separation between the E-rays and O-rays emerging out of a Wollaston prism made of calcite crystal when the unpolarised beam is incident normally on its surface.

(Given refractive indices of calcite for E-rays and O-rays are 1.658 and 1.486 respectively)

5

4. Explain the construction and working principle of Ruby laser. Discuss its disadvantages. 4+4+2=10

**OR**

What is population inversion? A beam of light is passing through a medium. Show that for amplification of the light within the medium  $N_2$  should be greater than  $N_1$ , where  $N_1$  and  $N_2$  are electron population density of the lower and upper energy levels associated with emission process. Discuss briefly the optical pumping process. 2+5+3=10

5. Define acceptance angle of an optical fiber. Derive an expression for numerical aperture. The critical angle for core-cladding interface of a fiber is  $30^\circ$ . Calculate the value of acceptance angle, if the core of the fiber has refractive index 1.5. Discuss the advantages of monomode fiber and multimode fibre.  $2+4+1+3=10$

**OR**

Explain the working principle of oil immersion objective. How spherical and chromatic aberration are minimised in such objective? Discuss its advantages over dry objective.  $4+4+2=10$

6. Write short note on : **(any one)** 5
- (a) Liquid Crystal Display
  - (b) Optical Communication.

## Group - B

### (Electromagnetic Theory)

Marks : 20

7. Answer the following questions :  $1 \times 3 = 3$

(i) The value of refractive index of a non-magnetic material with relative permittivity equal to 16 is :

(a) 16

(b) 256

(c) 4

(d) 8

(ii) The correct sequence to find  $\vec{H}$ , when  $\vec{D}$  is given is :

(a)  $\vec{D} \rightarrow \vec{E} \rightarrow \vec{B} \rightarrow \vec{H}$

(b)  $\vec{D} \rightarrow \vec{B} \rightarrow \vec{E} \rightarrow \vec{H}$

(c)  $\vec{D} \rightarrow \vec{H}$

(d) It cannot be computed from the given data

- (iii) Identify the polarisation of the e-m wave, given  $E_x = 2 \sin \omega t$  and  $E_y = 3 \sin \omega t$ .
- (a) Linear
  - (b) Elliptical
  - (c) Circular
  - (d) Parabolic

8. Calculate the magnitude of conduction current density, if the magnetic flux intensity is  $(\hat{i}y + \hat{j}z + \hat{k}x)$  units. 2
9. State and prove Poynting's theorem. 5

**OR**

- Obtain an expression for the energy density of an electromagnetic field. 5
10. (a) Starting from Maxwell's equations, obtain the electromagnetic wave equation. 4

- (b) Define skin depth. Derive an expression for the skin depth in case of a homogeneous and isotropic conducting medium. 1+5=6

**OR**

- (a) Derive an expression for reflection coefficient considering oblique incidence of an electromagnetic wave with electric field vector parallel to plane of incidence. 7
- (b) Derive the expression for Brewster's angle. Why is it called angle of polarisation? 2+1=3
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