(This Question paper contains 2 printed page)

Your Roll No.....

Sr. No. of Question Paper : 1746
Unique Paper Code : 2512013602
Name of the Course : B.Sc.(H) Electronics (Core)
Name of the Paper : Photonics
Semester : VI
Duration : 3 Hours
Maximum Marks : 90

Instruction for Candidates

1. There are seven questions in all, out of which you have to attempt any *five* questions.
2. All questions carry equal marks.
3. First Question is Compulsory.
4. Use of a non-programmable scientific calculator is allowed.

1. (a) A non-reflecting single layer coating is to be deposited on a lens of refractive index 1.78. Determine the refractive index of a coating material and the thickness required to produce zero reflection for light of wavelength 550 nm.
(b) Explain the effect of decreasing the slit width on diffraction pattern, keeping the distance between the two slits unchanged, for double slit diffraction.
(c) What is Brewster's law. Plot the reflectance as a function angle of incidence for light polarized parallel and perpendicular to the plane of incidence on the interface from the denser medium.
(d) What should be the thickness of a half-wave quartz plate for a wavelength of 590 nm, given the ordinary and extra-ordinary refractive indices as $n_o = 1.5442$ and $n_e = 1.5533$.
(e) Explain the principle and working of a phototransistor.
(f) Explain why the waveguide modes are discrete. (6 x 3)

2. (a) Derive an expression for the intensity distribution in a single slit Fraunhofer diffraction pattern. Also give the position of maxima and minima. (9)

(b) Explain with necessary theory how circular rings are obtained in Newton's ring method? Also explain how it is used for measuring wavelength of light. Why the central fringe is dark? (9)

3. (a) Explain the concept of Holography with reference to interference/diffraction. Derive an expression explaining the formation of virtual image and real image of an object. (9)

(b)Explain the Phenomenon of double refraction in Uniaxial Crytal. What is the significance of optic axis. (5)

(c) What is a quarter wave plate? Deduce its thickness for a given wavelength in terms of its refractive indices. (4)

4. (a) Explain the missing orders in double slit diffraction pattern. The two slits of a double slit each having a width of 0.140 nm and distance between centres of 0.840 nm. (i) what orders are missing (ii) find number of interference maxima occurring under the central diffraction maxima. (8)
(b) Two spectral lines at a wavelength of 6200 Å have separation of 0.652 Å. Find the minimum number of lines a diffraction grating must have to just resolve this doublet in the second order. (4)
© What is the major advantage of an LCD over other common display devices? Discuss

the working of an LCD device. (6)

5. (a) Explain why the semiconductor diode laser is forward biased for its operation. Draw and explain various regions of its light output-current characteristic. Also plot its radiant output as a function of frequency for
   (i) below threshold
   (ii) above threshold. (6)
   (b) Derive the relation between the Einstein coefficients for spontaneous emission and stimulated emission. Explain why Ruby laser is classified as a solid-state laser and CO2 laser as a gas laser. (7)
   (c) With the help of diagram, explain why the intrinsic layer is important in *p-i-n* photodiode. (5)

6. (a) Why is total internal reflection crucial for optical fiber communication? Show mathematically how the critical angle depends on refractive indices of the two media. (6)
   (b) A step index fiber has a core diameter of 80 μm, a core refractive index of 1.62, and a numerical aperture of 0.21. Calculate: (i) the acceptance angle, (ii) the refractive index of the clad, (iii) the number of modes that the fiber can support at a wavelength of 0.8 μm. (6)
   (c) Define a mode supported by a waveguide. A symmetric planar waveguide has core refractive index n_1 = 1.48, cladding refractive index n_2 = 1.46, and operating wavelength of 1.3 μm. Find the minimum core thickness required to support the fundamental TE_0 mode. (6)

7. (a) A Si *pin* photodiode has an active light receiving area of diameter 0.4 mm. When radiation of wavelength 700 nm and intensity 0.1 mW cm^{-2} is incident it generates a photocurrent of 56.6 nA. What is the responsivity and quantum efficiency of the photodiode? (6)

   (b) Explain the terms spontaneous emission, stimulated emission and population inversion. Discuss how the positive feedback is obtained in lasers. (8)
   (c) On what factors does the performace of fiber-optic link depend? What are the causes of the distortion in a single mode fiber? (4)
   Values of some constants: (h = 6.62 x 10^{-34} Js, e = 1.6 x 10^{-19} C)

(1000)