Total number of printed pages – 7

B. Tech

CPEN 5304

Sixth Semester Examination – 2009

FIBRE OPTIC INSTRUMENTATION

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

(Plank's constant = 6.6256×10^{-34} J-Sec)

1. Answer the following questions : 2×10

   (a) What is a "direct band gap material" ? What is the importance of this in fiber optic instrumentation ?

P.T.O.

(b) A light source generating an optical power equal to 1 μ-watt is coupled into an optical fibre with a cross sectional area larger than that of the active area of the light source. Determine the power coupled into the fibre with a fibre acceptance angle of 30°

(c) What are "Impact Ionization" and "Avalanche Effects" ?

(d) Define "minimum detectable optical power". Also list the principal noises associated with photo-detectors those have no internal gain.

(e) What are "Active Glass Fibres" ? Describe the properties of these fibres.

(f) Distinguish between "Mie Scattering" and "Rayleigh Scattering".

(g) What are the factors which optical power launching from source to fibre depends on ?

(h) How are the Fibre Optic Sensors classified ?

(i) Explain "Stokes Fluorescence". Why is it important in fibre optic instrumentation ?

(j) Describe the construction of Fresnel Zone Plate. What will happen if a parallel beam of light is incident on the Zone Plate ?

2. (a) A double hetero-junction InGaAsP LED emitting at a peak wavelength of 1310 nm has radiative and non-radiative recombination times of 30 and 100 ns respectively.

The drive current is 40 mA. Calculate the internal power generated in LED. 5

(b) Write the Laser diode rate equations that govern number of photons generated and number of electrons in the active region. Derive the number of electrons that must be exceeding a threshold value so that number of photon generated increases. 5

3. (a) List three basic structures of LASER diodes based on optical confinement method and draw their radiation patterns. Also list three types of LASERs using built-in frequency selective reflectors. 5

(b) Write the condition for the phase of the wave inside the active region at lasing

threshold. Prove that the cavity resonates when an integer number of half wavelength spans the region between the mirrors. 5

4. (a) Explain the propagation of ray in step index as well as graded index fibres. Draw ray diagrams whenever necessary. 5

(b) List the effects and causes of the following attenuation mechanisms : 5

(i) Absorption

(ii) Scattering

(iii) Bending Losses.

5. (a) A GaAs optical source with a refractive index of 3.6 coupled to a silica fibre that has a refractive index of 1.48. If the fibre end and the source are in close physical contact, calculate the power loss in

decibels. Suggest a method of reducing this loss. 5

(b) Describe various lensing schemes for coupling optical power into the fibre. 5

6. (a) Describe the construction and principle of measurement of Mach-Zehnder interferometric sensors. 5

(b) Write basic principle of the following fibre optic sensors : 5

(i) Fibre Bragg Grating sensor

(ii) Fibre Optic Gyroscope.

7. (a) Suggest a method for the following with suitable diagram : 5

(i) Detection of Oil Droplet in water

(ii) Detection of liquid level.

(b) Explain the phenomena of "constructive interference" and "destructive interference". Draw suitable diagrams and derive the expressions to explain the above phenomenon. 5

8. Write short notes on any *two* : 5×2

(a) Littrow Diffraction Grating

(b) Hot body source

(c) Optical amplifier

(d) Distributed Fibre Optic Sensor.