Registration No. :

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B. Tech

CPEN 5304

Sixth Semester (Special) Examination – 2013

FIBER OPTIC INSTRUMENTATION

BRANCH : AEIE, IEE

QUESTION CODE : E 323

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.

1. Answer the following questions :   2×10

   (a) Write down the fundamental quantum–mechanical relationship between energy and frequency. If Eg is 1.43 for GaAs, find λ.

   (b) What are the three key transition processes involved in Laser action ?

   (c) How do you realise a reach-through avalanche photodiode ?

   (d) List different sources of noise in a photo detector.

   (e) What are the various requirements that must be satisfied, in selecting materials for optical fibre ?

   (f) Describe a step-index optical fibre.

   (g) List the differences between single=mode and multi-mode optical fibres.

   (h) How can you improve the source to fibre coupling efficiency ?

   (i) Draw a generalised configuration of a fibre-optic sensor.

   (j) What is an Erbium-doped fibre amplifier ?

2. (a) Why is a direct band gap semiconductor suitable as LED ? Draw the schematic of a surface-emitting LED.   5

   (b) A double-heterojunction InGaAsP LED emitting at a peak wavelength of 1300 nm has radiative and nonradiative recombination times of 30 and 100 ns. respectively. If the drive current is 30 mA, $h = 6.62 \times 10^{-34}$ J s and $c = 3 \times 10^8$ m/s find the bulk recombination life time and internal power level.   5

P.T.O.

3. (a) How modulation of Laser diodes is achieved ? Describe any type of Laser structure using built-in frequency-selective resonator grating.   5

   (b) A GaAs laser operating at 850 nm has a 500 μm length and a refractive index n = 3.5. What are the frequency and wavelength spacings ? If, $\lambda - \lambda_o = 2$ nm, what is the spectral width σ of the gain ?   5

4. (a) Explain the working of a fibre-optic gyroscope using a suitable illustration.   5

   (b) A fibre-optic gyroscope has a circular coil of diameter 0.1 m and the total length of optical fibre used in the coil is 600 m. What is the phase shift corresponding to the earth's rotational speed, if it is operating at $\lambda = 0.9$ mm. $\Omega = 7.3 \times 10^{-5}$ m rad s^{-1}.   5

5. (a) Describe the principle of operation of a PIN photo-detector using energy band diagram.   5

   (b) A GaAs photodiode has a band gap energy of 1.43 eV at 300° K. What is the maximum photon wavelength for which the photodiode will operate ? (Use data available elsewhere in the question paper)   5

6. (a) Differentiate between step-index and graded-index fibre. What do you understand by numerical aperture of fibre ?   5

   (b) How does the ray propagate in a graded–index fibre ? Explain the terms pulse broadening and multipath time dispersion of the fibre.   5

7. (a) A Ga As optical source with a refractive index of 3.6 is 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 find the Fresnel reflection at the interface and the power loss in dB. Derive the expression used.   5

   (b) Draw the schematic of a semiconductor optical amplifier explain the working.   5

8. Write short notes on any **two** of the following :   5×2
   (a) Mach-Zehender interferometric sensor
   (b) Fabry-Perot amplifier
   (c) Attenuation in optical fibres
   (d) Modulation of Laser diode.