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Reg. No. : ....

Name : ....

Seventh Semester B.Tech. Degree Examination, May 2013
(2008 Scheme)
08.735 : OPTOELECTRONIC DEVICES (TA)

Time : 3 Hours Max. Marks : 100

PART – I

Answer **all** questions.

1. What is Auger Recombination ?
2. Determine the cut off wavelength for a GaAs semiconductor material whose bandgap energy is 1.43 eV at 300°K.
3. Draw the structure of PIN diode and briefly discuss its operation.
4. Explain characteristics of laser beam.
5. The total efficiency of an injection laser with a GaAs active region is 20%. The voltage applied is 3V and the band gap energy of GaAs is 1.43eV. Calculate the external power efficiency of the device.
6. Why four level system is preferred in population inversion ?
7. A 5 cm^2 Ge solar cell with a dark reverse saturation current of 2nA has AM1 radiation incident upon it producing 4×10^{17} electron-hole pairs per second. The electron and hole diffusion lengths may be assumed to be 5 micro m. Calculate the short circuit current and open circuit voltage of the cell.
8. Briefly explain the Electro-optic measurement technique.
9. Calculate the responsivity of the device if the number of incident photons are 800 and the corresponding electron generation in photodiode is 500 at a wavelength of 1300 nm.
10. Briefly discuss the mode hopping in Lasers. **(10×4=40 Marks)**

P.T.O.

PART – II

Answer **any 2** from **each** Module.

Module – I

11. What are direct band gap and indirect band gap semiconductors ? Explain the different mechanism of electron-hole recombination.

12. Consider a PN junction semiconductor sample. At equilibrium the acceptor concentration at P type region is $N_A = 10^{16} cm^{-3}$ and that of in N region the donor concentration $N_D = 5 \times 10^{15} cm^{-3}$. At a particular temperature the hole concentration in P region is determined to be $1.1 \times 10^{16} cm^{-3}$. Find the intrinsic concentration ni for the semiconductor at this temperature. Find the equilibrium electron concentration n in the N region at this temperature.

13. Draw the layer diagram and operation of APD. An APD has a quantum efficiency of 40% at 1300 nm. When illuminated with optical power of 0.3 W, it produces an output current of $6 \mu A$, after avalanche gain. Calculate the multiplication factor of the diode. **(2×10=20 Marks)**

Module – II

14. Explain Lambertion pattern of an LED with diagram.

15. Derive the relation to find the numerical aperture of a step index fiber. A GaAs LED is coupled through air ($n_r = 1$) to a step index glass fiber ($n_{r1} = 1.5$). Find the acceptance angle.

16. Discuss the principle of operation of different electro-optic modulators. A typical transverse electro-optic modulator uses $LiNbO_3$ crystal and operates at 550 nm. Calculate the length of the crystal required to produce a phase difference of 90° between the emergent field components with zero applied field. **(2×10=20 Marks)**

Module – III

17. Explain the working principle of single quantum well and multiple quantum well lasers.

18. a) Derive the threshold condition for laser action.

    b) On what factors does the gain coefficient of a semiconductor laser depends.

19. Explain FP laser. Calculate the mirror reflectiveness needed in GaAs-AlGaAs double hetro structure laser in which the FP cavity length is 20 mico meter and the cavity loss is $10 cm^{-1}$. The optical confinement factor is unity and the threshold gain in the medium is $10^3 cm^{-1}$. **(2×10=20 Marks)**

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