(c) An InGaAs p-i-n photodiode has the following parameters at a wavelength of 1310 nm - $I_D = 4\,nA$, $\eta = 0.90$, $R_L = 1000\,\Omega$ and surface leakage current is negligible. The incident power is $200\,\mu w$, and the receiver bandwidth is 200 MHz. Find various terms of the receiver.

(d) Explain the impact ionization in Avalanche photodiodes. Define photomultiplication factor and cutoff wavelength of photodiode.

5 Attempt any two of the following : 10×2=20

(a) Explain the major elements of an optical fiber receiver. Describe the usage of preamplifier and technique for automatic gain control in APD receiver.

(b) What is coherent detection ? How many kinds of coherent detection system may be designed ? Explain the advantage of coherent detection system over the direct detection system.

(c) Explain link power budget. A 5 km length optical fiber link has a fiber cable which has an attenuation of 4 dB km^{-1}. The splices are 0.7 dB km^{-1} and connector losses at the source and detectors are 4 and 3.5. Considering no dispersion on the link, calculate the total channel loss.

(d) Explain the following terms :

(i) ASK, FSK, PSK modulation

(ii) System design consideration for optical fiber communication.

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(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0304 Roll No.

B. Tech.

(SEM. VII) EXAMINATION, 2008-09

OPTICAL FIBER COMMUNICATION

Time : 3 Hours] *[Total Marks : 100*

Note : *(i) Attempt **all** questions.*

*(ii) All questions carry **equal** marks.*

(iii) Be precise in your answer.

(iv) No second answer book will be provided.

1 Attempt any four of the following : 5×4=20

(a) What is the structure of an optical fiber ? Give advantages of optical fiber over metallic cables.

(b) What is difference between single mode and multimode fiber ? Find the NA and core radius of the fiber for a single mode fiber operating at 1300 nm with $n_{core} = 1.5$ and $n_{clad} = 1.45$.

(c) Prove that propagation constant of an optical fiber is the product of free space propagation constant and the rms value of its core-cladding refractive indices. Given normalized propagation constant is half (1/2).

(d) Calculate the number of modes at 820 nm and 1.3 μm in graded index fiber having a parabolic index profile $(\alpha = 2)$, a 25 μm core radius, $n_1 = 1.48$ and $n_2 = 1.46$. How does this compare to a step index fiber ?

(e) Explain the importance of mode field diameter for single mode fiber, with suitable diagram.

(f) A step index fiber is constructed with $n_1 = 1.450$, $n_2 = 1.445$ and $a = 4.0\ \mu m$.

(i) Will this fiber be single mode when the operating wavelength is $\lambda = 1.55\ \mu m$?

(ii) Evaluate the cutoff wavelength λ_c for LP_{11}.

2 Attempt any **four** of the following : 5×4=20

(a) What is signal attenuation mechanism in a fiber ? What is the unit of attenuation ?

(b) A single mode fiber has an attenuation of 0.5 dB/km, when operating at a wavelength of 1310 nm. The core diameter is $8\ \mu m$ and source bandwidth 500 MHz. Compute the threshold optical powers for stimulated Brillouin and Raman scattering.

(c) Explain what is meant by the critical bending radius for an optical fiber.

(d) Explain the mechanism of intermodal dispersion in a multimode step index fiber. And show that broadening of light pulse δT_s is given as $\delta T_s = \frac{L(NA)^2}{2 n_1 c}$.

(e) Describe dispersion shifted and dispersion flattened single mode fibers.

(f) Two fibers having same polarisation and operating at a wavelength of $0.8\ \mu m$ have beat lengths of 0.5 mm and 75 m. Find the modal birefringence in each case and interpret the length.

3 Attempt any **four** of the following : 5×4=20

(a) What is the major advantage of heterostructure LED over a homostructured one ? Calculate the cutoff wavelength of GaAs material with optical energy gap of 1.4 eV at 273 °K.

(b) Explain semiconductor injection laser. Find its internal quantum efficiency and show how it is related to the differential external quantum efficiency.

(c) Find the external power efficiency of GaAs planer LED having refractive index of 3.6 with transmission factor of GaAs air interface of 0.70. The internally generated optical power is 30% of the electric power supplied.

(d) What is the difference between a surface emitting LED and edge emitting LED. An injection laser has a total efficiency in the Gallium Arsenide active region as 20%. The voltage applied to the device is 2.2 volts. If the bandgap energy of GaAs is 1.43 eV, find the external power efficiency of the device.

(e) Find the number of longitudinal modes of a laser having a crystal length of 7 cm, refractive index 1.5 and peak emission wavelength of 0.5 μm. Also find their frequency separation.

(f) What does "FWHM" stand for ? How does it apply to an LED characteristics ?

4 Attempt any **two** of the following : 10×2=20

(a) What are the requirements of photodetector ? Calculate the efficiency a PIN silicon photodiode if the responsivity is 0.374 AW^{-1} at 1300 nm wavelength.

(b) How is silicon RAPD operated ? How does it differ form P-i-n photodiode. What are the advantage and disadvantage of RAPD detector ?