

(v) Which of the following will not reduce the number of modes that an optical fiber can carry ? 1

- (a) Reducing core diameter
- (b) Reducing NA
- (c) Increasing wavelength
- (d) Reducing attenuation.

(vi) Which of the following is an important advantage of external modulation of lasers? 1

- (a) Simpler operation
- (b) Does not require electrical power
- (c) More precise control over output
- (d) Avoids wavelength chirp that could cause dispersion.

(vii) Small values of NA decrease the pulse dispersion but increase losses due to 1

- (a) Absorption
- (b) Scattering
- (c) Bending
- (d) Microbending

(b) Attempt the following questions : 10

(i) Explain the concept of double hetero structure to achieve optical and carrier confinement. Also explain the concept of SLED.

(ii) A laser diode has lateral ($\phi = 0^\circ$) and transverse ($\phi = 90^\circ$) half power beam widths of $2\Theta = 60^\circ$ and 30° respectively. What are the transverse and lateral power distribution coefficients for the device?

2 Attempt any **two** : **16**

(i) What is NA? Derive an equation of NA for step index multi mode fiber. Explain the concept of V number and its relation with modes confined into the core.

(ii) Explain the basic structure of fiber optic cable. What will be the transmission length caused by the fiber loss if $p_{in} = 1$ mw and $p_{out} = 0.75$ mw with fiber attenuation $\alpha = 0.5$ dB/km.

- (iii) What is dispersion in multi mode fiber? Explain intermodal and chromatic dispersion. How dispersion can be reduced?

Calculate the loss of an optical fiber in dB/km, whose length is 150 m fed with an optical power of $15 \mu\text{W}$ and the output power is $7 \mu\text{W}$.

3 Attempt any two : 14

- (i) Explain the concept of pin photodiode and derive the equation of quantum efficiency for the same.

In a 100 ns pulse, 6×10^6 photons at a wavelength of 1300 nm fall on an InGaAs photo detector. On the average 5.4×10^6 electron-hole pairs are generated. Find the quantum efficiency for the same.

- (ii) Which are the important system parameters that must be consider for designing an optical communication link? Explain an analog fiber communication link with the help of block diagram.

Design an optical fiber communication link with a system capacity of 150 Mb/s and a length of 8 km. Given parameters are (i) splicing loss = 0.5 dB per splice dBm (Assume every splice at 4km) (ii) Connector loss = 1.5 dB (iii) power margin = 10 dB (iv) optical source output power (-10 dBm) (v) optical receiver sensitivity = (-50 dBm) (vi) fiber with attenuation loss = 2dB/km.

Comment whether system is functional or not. If system is not functional, change the design parameter in such a manner that system becomes functional.

- (iii) Define coupling efficiency. Derive the equation for the power coupled to the step index fiber from source. For laser diode that has a lateral half power beam width of $2\theta = 10^\circ$, find lateral power distribution coefficient.

SECTION - II

4 Answer the following : 20

- (i) List and explain the key system features of WDM.
- (ii) Consider an EDFA being pumped at 980 nm with a 30 mW pump power. If the gain at 1550 nm is 20 dB, find the maximum input power.

- (iii) What is cross talk in WDM? Explain the origin of interchannel crosstalk in a WDM system.
 - (iv) Explain the chromatic dispersion measurement method.
 - (v) With help of block diagram explain the basic optical fiber sensor system.
- 5 (a) Discuss general applications of optical amplifier. Explain working principle of semi-conductor amplifier and its advantages. 8
- (b) Calculate the material dispersion limited transmission distance for a silicon fiber link of data rate 100 Mpps operating at 840 nm with a spectral width of 50 nm. 7

The value of $\lambda^2 \left[\frac{d^2n}{d\lambda^2} \right] = 0.024$. The coding is RZ coding.

OR

- 5 (a) Explain broadcast and select single hop network. How it differs from broadcast and select multi hop network? 8
- (b) Pulse dispersion measurement are taken over a 1.2 km length of partially graded multimode fiber. The 3 dB width of the optical input pulses are 300 p.s and the corresponding 3 dB widths for the output pulses are round to be 12.6 ns. Assuming the pulse shapes and fiber impulse response are Gaussian, Calculate : 7
- (i) the 3dB pulse broadening for the fiber in ns km⁻¹
 - (ii) the fiber bandwidth-length product.
- 6 Write short notes on : (any three) 15
- (i) The 2 × 2 waveguide coupler.
 - (ii) EDFA power conversion efficiency and gain
 - (iii) SONET/SDH networks
 - (iv) Measurement of attenuation by the cutback technique
 - (v) Mech-Zehnder Interferometric sensor.