Problems :

1) A Data center is upgrading its fiber-optic backbone from 2.5 Gbps to 10Gbps to accommodate increased traffic demand. The system has the following rise-time components:

(i) Transmitter rise Time = 80ps

(ii) Fiber dispersion rise Time = 100ps

(iii) Receiver rise Time = 60ps

(a) Explain the concept of rise-Time budget analysis in high speed digital transmission.

(b) Calculate the total system rise time using the given values.

(C) compare the total rise time with the maximum allowable rise time for 10 Gbps using the equation:

$$t_{max} = \frac{0.7}{\text{Bit Rate}}$$

Sol:-

(b) Calculation of Total System Rise Time :-

The total system Rise Time (t_{sys})

$$t_{(sys)} = \sqrt{t_T^2 + t_D^2 + t_R^2}$$

Given values,

$$t_T = 80ps$$

$$t_D = 100ps$$

$$t_R = 60ps$$

$$t_{sys} = \sqrt{(80)^2 + (100)^2 + (60)^2}$$

$$= \sqrt{6400 + 10000 + 3600}$$

$$= \sqrt{20000}$$

$$t_{sys} = 141.42ps$$

(c) Comparison with Maximum Allowable Rise Time

$$t_{max} = \frac{0.7}{\text{Bit Rate}}$$

for 10 Gbps system:

$$t_{max} = \frac{0.7}{10 \times 10^9}$$

$$t_{max} = 70 \text{ ps}$$

Comparison:

→ The calculated total rise time is 141.42ps which is greater than allowable limit of 70ps for a 10 Gbps system.

⇒ Indicates that the current system may not support 10Gps transmission without significant signal degradation due to insufficient bandwidth & dispersion-related broadening.

2) An optical fiber system has a 60 km link with fiber attenuation of 0.22dB / km. The system includes 4 splices (0.15dB each) and 2 connectors (0.9dB each). If the transmitter power is 10 dBm, will the receiver (with sensitivity of -20dBm) receive a strong enough signal?

Solu:

Given; fiber length = 60 km

Fiber Attenuation = 0.22 dB/km

Number of splices = 4

Splice loss per splice = 0.15dB

Number of connector = 2

Connector loss per connector = 0.9dB

Transmitter power = 10dBm

Receiver sensitivity = -20dBm

Step-1: Total fiber Attenuation

Fiber loss = 60km × 0.22dB/km

FL = 13.2dB

Step : 2 total splice loss

Splice loss = 4 × 0.15 dB = 0.6 dB

Step 3 : Total connector Loss

Connector Loss = 2 × 0.9 dB = 1.8 dB

Step 4 : Total link Loss

Total Loss = 13.2 + 0.6 + 1.8 = 15.6 dB

Step 5 : Received Power

Received power = Transmitter power − Total loss

= 10 dBm − 15.6 dB

Received power = −5.6 dBm

Step : 6 compare with receiver sensitivity

→ Received power = −5.6 dBm

→ Receiver sensitivity = −20 dBm

Since −5.6 dBm > −20 dB, the signal is strong enough, providing margin of 14.4 dB which is excellent for reliable communication