Example 8.3 - Pg: 312

11. **Solution:**

Given: Transmitter Rise Time ($t_{tx} = 15ns$)

Material Dispersion Rise time ($t_{mat} = 21ns$)

Modal dispersion Rise time ($t_{mod} = 3.9ns$)

Receiver Rise time ($t_{rx} = 4ns$)

Maximum allowable system rise time for 20Mb/s NRZ Signal:

$$t_{max} = \frac{0.7}{\text{bit rate}} = \frac{0.7}{20 \times 10^6} = \boxed{35nS}$$

To Find: Total System Rise Time (t_{sys}):

Formula: $t_{sys} = \sqrt{t_{tx}^2 + t_{mat}^2 + t_{mod}^2 + t_{rx}^2}$

where:

t_{tx}: transmitter rise time (LED + drive circuit)

t_{mat}: material dispersion rise time (due to fiber properties)

t_{mod}: modal dispersion rise time (for multimode fibers)

t_{rx}: Receiver rise time.

From the Problem;

$t_{tx} = 15ns$, $t_{mat} = 21ns$, $t_{rx} = 14ns$

Modal dispersion Time t_{mod}:

→ The fiber has 400 MHz-km bandwidth-distance product.

→ distance $L = 6km$

→ By using the equation;

$$t_{mod} = \frac{350 \times L}{B_e}$$

where;

$$B_e = q \times B_0 = 0.7 \times 400$$

$$\boxed{B_e = 280\ MHz}$$

So,

$$t_{mod} = \frac{350 \times 6}{280} = \frac{2100}{280} \approx 7.5\,ns$$

But; t_{mod} is given ; where $t_{mod} = 3.9\,ns$

To calculate total system rise time (t_{sys});

$$t_{sys} = \sqrt{t_{tx}^2 + t_{mat}^2 + t_{mod}^2 + t_{rx}^2}$$

$$= \sqrt{(15)^2 + (21)^2 + (3.9)^2 + (14)^2}$$

$$= \sqrt{225 + 441 + 15.21 + 196} = \sqrt{877.21} \approx 29.61$$

$$\boxed{t_{sys} = 30\,ns}$$

The total signal rise time is 30ns, which is

- Less than 35ns, which is the maximum allowed for a 20 Mb/s NRZ (Non-return-to-Zero) system.

∴ The rise-time budget is acceptable and the System works properly for this data rate.