1 (a) (i) Explain time dispersion in bulk media and show that:

\[ \frac{\tau}{l} = \frac{\gamma}{c} |Y_m| \]

Where \( Y_m \) represents the material dispersion coefficient.

(ii) Light traveling in air strikes a glass plate at an angle \( \theta_1 = 35^\circ \), where \( \theta_1 \) is measured between the incoming ray and glass surface. Upon striking the glass part of the beam is reflected and part is refracted. If the refracted and reflected beams make an angle of 90\(^\circ\) with other, what is the refractive index of glass? What is the critical angle for this glass?
(b) Derive the expression of numerical aperture and multipath dispersion in step index fiber using a ray model.

(c) (i) Define RMS pulse width in terms of spread of wavelength.
(ii) Explain frequency response. Define optical and electrical bandwidth.

2 (a) Explain the time dispersion in step index fiber and derive the expression for the pulse spreading $\tau_{km}$ of the $(k, m)$ mode over the distance $L$.

(b) Discuss the single mode step index fiber. Why the single mode system is more preferable? Show that the waveguide dispersion for step index fiber is dependent on the core diameter.

(c) What is weakly guiding fibers? What is the advantage of weakly guiding solution? Show that the total number of modes propagating in step index fiber is:

$$M = \left(\frac{2\pi}{\lambda^2}\right) A_c (NA)^2$$

Where $A_c$ is the core area.

3 (a) (i) Consider a parabolic index waveguide with core and cladding refractive indices are $1.750$ and $1.667$ respectively. The core diameter is $40 \mu m$ Calculate the numerical apretature at the axis and at a point $20 \mu m$ from the axis.

(ii) For a typical graded index fiber with $\alpha = 2$, $n_0 = 1.47$, $\Delta = 0.01$ and core radius is $25 \mu m$. Calculate the number of propagating modes.

(iii) Consider a fiber with $n_0 = 1.50$ and $\Delta = 0.01$. Calculate the dispersion for a graded index fiber. Assume that the material dispersion is zero.
(b) (i) Derive the expression for intermode dispersion in the presence of material dispersion.

(ii) Using the result obtained in (i) calculate the value of $\alpha$ required for minimum dispersion.

(c) Explain the variation in propagation constant. Show that the difference in propagation constant between adjacent mode group is:

$$\Delta \beta = \frac{\beta_0 \Delta 2q}{Q^2}$$

4 (a) What do you mean of intermodulation dispersion? Draw the test circuitry for measuring intermodulation dispersion and explain it

(b) Explain how the eye pattern technique is used for assessing the data handling ability of a digital transmission system? Also draw the simplified eye pattern diagram and what informations are achieved from it?

(c) Explain in detail the interferometric method and focusing method of refractive index profile measurement.

5 (a) Describe various vapour deposition techniques that are used to fabricate high silica fibers.

(b) (i) What do you mean of splicing? Explain various techniques of splicing.

(ii) What are the mechanical properties of the fiber?

(c) Draw the general configuration of fiber optic cable and explain it.