1994 Paper 9 Question 2

Developments in Technology

Either   A multimode graded index fibre has a core of radius a and refractive index $n(r)$, where r is the radius measured from the fibre axis. Show that the equation of a light ray launched at radius r_0 along the fibre core, parallel to the fibre axis, is given by

$$\frac{d^2r}{dz^2} = \frac{1}{2\beta^2} \cdot \frac{dn^2}{dr}$$

where $\beta = n(r_0)$. [8 marks]

The fibre core has a parabolic variation of index with radius, described by

$$n^2(r) = n_{co}^2(1 - \alpha r^2)$$

Show that a short length of the fibre can act as a lens, and derive an expression for its focal length in terms of α, n_{co}, and β. [8 marks]

Explain qualitatively how such a fibre minimises the spreading of an optical pulse propagating along it. [4 marks]

or   Describe any one optical system in a compact disc player. In your answer pay particular attention to the following:

- how information is recorded and read from the disc's surface

- the limitations on the disc's storage capacity

- the laser focusing system

- the optical tracking system [20 marks]