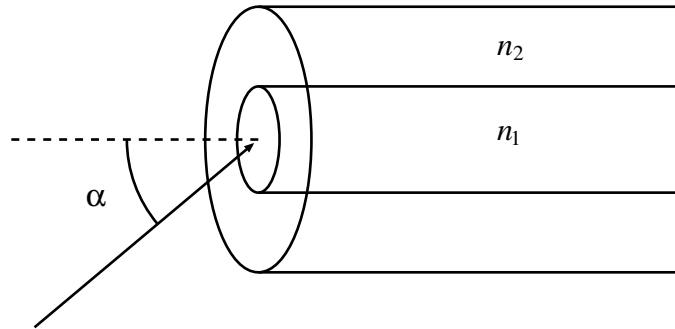


1995 Paper 13 Question 5

Developments in Technology

Light is incident from air on the end face of a multimode optical fibre at angle of incidence α as shown below.



The refractive indices of the core and cladding are n_1 and n_2 respectively, where $|n_1 - n_2| \ll 1$. Prove the following condition for the incident light to be guided by the fibre

$$\sin \alpha \leq \sqrt{n_1^2 - n_2^2} \quad [4 \text{ marks}]$$

What is the main cause of pulse spreading in a step index multimode fibre?

[3 marks]

Show, for the same fibre parameters as given above, that the bandwidth \times length product for the fibre is given approximately by

$$B.L = \frac{nc}{(n_1^2 - n_2^2)}$$

where c is the speed of light in free space, and the approximation $n_1 \approx n_2 \approx n$ has been made.

[5 marks]

Explain carefully how, by appropriate design of the multimode fibre, the bandwidth might be increased.

[3 marks]

Explain carefully what is meant by the term *material dispersion* in an optical fibre, explaining its relative importance for single and multimode fibres. How might it be minimised?

[5 marks]