Module 1 Unit 2

OPTICAL FIBRES - NUMERICALS

(As per Revised Curriculum SVU R-2023)

Physical constants:
Speed of light c = 3 x 10^8 m/s

Classwork:

1. The core and cladding refractive index for a step index optical fibre are 1.46 and 1.42 respectively. Determine its numerical aperture and acceptance angle.
2. The acceptance angle of an optical fibre is 25°. Calculate refractive index of cladding if refractive index of core is 1.52.
3. A fibre has acceptance angle of 25° and internal critical angle of 70°. Determine core and cladding refractive index and fractional refractive index.
4. The numerical aperture of a step index optical fibre is 0.3 and its core radius is 0.05 mm. Find the normalized frequency and number of allowed modes if it is operated at 1.3 μm.
5. What is the limiting radius for an optical fibre having numerical aperture of 0.025 to serve as single mode fibre at 850 nm?
6. The input power of a 5 mW laser decreases to 0.2 mW after traversing a 50 km long optical fibre. Determine attenuation coefficient of the fibre.
7. Calculate length of an optical fibre having loss factor 0.2 dB/km if input power decreases by 90% on traversing this fibre.
8. A 10 km long optical fibre link with a loss of 0.2 dB/km is fed with signal from a 5 mW laser source. Calculate the power received at the output. If this fibre has two connectors in its path each with a loss factor of 1 dB, calculate the percentage decrease in power output as compared to earlier case.
9. Refractive indices of core and cladding of a step index fibre are 1.48 and 1.45 respectively. How much is the intermodal dispersion in ns if length of this fibre is 2500 m?
10. Consider a graded index multimode optical fibre having cladding refractive index of 1.42 and fractional refractive index of 0.025. Calculate the maximum bit rate for optical data transmission from this fibre of length 2 km. Assume material dispersion offered by fibre in be 1.7 ns/km.

Homework:

1. In The internal critical angle for an optical fibre is 82°. Calculate its acceptance angle if core RI is 1.44.
2. A fibre has core RI 1.5. Find its cladding RI if its acceptance angle is 8° when immersed in water. RI of water is 1.33.
3. A step index optical fibre supports 1325 modes at an operating wavelength of 1.3 μm. Determine its core radius if the numerical aperture is 0.3.
4. The core and cladding refractive index for a graded index optical fibre are 1.46 and 1.42 respectively and its core radius is 0.05 mm. Find the normalized frequency and number of allowed modes if it is operated at 1.3 μm.
5. An optical fibre has core radius of 5 μm Will it act as a single mode fibre at 850 nm? Its core and cladding RI are 1.4 and 1.399 respectively.

6. Light output from a 20 km long optical fibre having attenuation coefficient of 0.25 dB/km is 25 µW. What would be the input power?
7. The measured output power after amplification is 10 mW. If the amplifier has a gain factor of 100 and attenuation factor of the fibre is 0.2 dB/km, what is the length of fibre if input power is 10 mW.
8. RI of core of a step index is 1.46 and fractional RI is 0.015. Express the intermodal dispersion of for this fibre in ns/km. How much is the dispersion if length of this fibre is 500 m?
9. The data speed measured over a 1 km long graded index fibre is 100 MBPS. Material dispersion due to the fibre is 1.5 ns/km. Determine the acceptance angle need to be maintained by a source if fractional RI of this fibre is 0.052.
10. A 5000 km long optical fibre communication hotline has amplifiers connected at every 1000 km. Optical fibres used between them have attenuation factor of 0.3 dB/km. If 10 mW input power is fed into the first fibre, the output power at the last fibre (but before amplifier) is measured to be 0.5 µW. Determine the amplification factor of amplifiers placed in the link. Assume all amplifiers are the same with identical gain.

==========