

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2023-2024
EEE F426 FIBER OPTICS AND OPTOELECTRONICS
MID-SEMESTER TEST (CB) October 14, 2023

DURATION: 90 min

Max. Marks: 60

Note: All questions equal marks. State valid assumptions and consider typical values wherever necessary.

Consider a teleservice company situated in Jaipur has been assigned a task to deliver data to subscribers at Pilani Town. The company decides to connect office at Pilani using a step-index SMF and deliver data to subscribers at last mile by employing a step-index MMF, both operating at 1310 nm. The source at Jaipur is a laser emitting a power of 3.2 mW and FWHM of 5 nm while a LED is employed at Pilani office with a power output of 8 mW and FWHM of 5 nm. The SMF with 8 μm diameter has a core index of 1.485 with a $\Delta = 0.003$ while MMF has a diameter of 12 μm with core index of 1.480 and $\Delta = 0.002$. Assume a distance of 200 km from Jaipur to Pilani and all subscribers are located within a radius of 5 km around the office at Pilani. The SMF roll has a maximum span of 40 km with an attenuation coefficient of 0.22 dB/km. The MMF exhibit an attenuation coefficient of 3 dB/km.

Determine:

- [1] The numerical aperture and acceptance angle for both SMF and MMF.
 - [2] The combined (multipath + material) dispersion for the MMF. Which one dominates?
 - [3] The total number of modes propagating in the MMF and their effective indexes and phase velocities.
 - [4] The pulse dispersion in case MMF is a GI fiber with an optimized refractive index profile.
 - [5] The power carried in each mode observed in (3) and confined in core of the MMF.
 - [6] The percent reduction in the diameter of SMF when required total dispersion, $D = 0$ and D_m for SMF is 10 ps/ nm.km.
 - [7] The mode field diameter, w_P and associated joint loss (in dB) for SMF. Assume lateral misalignment of 0.2 μm .
 - [8] The critical radius of curvature to avoid bending losses expected to observe with SMF.
 - [9] The splicing losses due to extrinsic factors in SMF to increase span in order to cover 200 km, consider the same lateral misalignment as mentioned in (7) to be the only reason for splice loss.
 - [10] The power (in nW) received at Pilani office and power (in mW) received by a subscriber at Pilani. Assume the signal is regenerated at the office and each connector at an end add to a loss of 0.5 dB.
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