



Eighth Semester B.E. Degree Examination, Dec.2024/Jan.2025s

Optical Communication Networks

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Define Numerical Aperture(NA) and the acceptance angle θ_a with reference to meridional ray propagation in an optical fiber. With a neat optical meridional ray diagram and by derivation relate :
 - i) NA with core-cladding refractive indices as well as with θ_a
 - ii) NA with the index difference Δ_n
 - iii) NA with relative refractive index Δ . (10 Marks)
- b. A typical relative refractive index difference for an optical fiber is 1%. Estimate the NA and the solid acceptance angle in air, when the core RI is 1.46. Also calculate the critical angle ϕ_c at the core-cladding interface. Assume that concepts of ray optics theory hold good for the fiber. (05 Marks)
- c. Outline and briefly explain any five advantages of optical fiber channels over copper wire/coaxial cable channels that are used in communication links as the transmission media. (05 Marks)

OR

- 2 a. Compare the meridional rays and skew rays in a light guiding optical fiber. (04 Marks)
- b. With a neat sketches of refractive index profile and light ray propagations, explain the features of :
 - i) Multimode step index fiber
 - ii) Single mode step index fiber
 - iii) Multimode graded index fiber (parabolic RI profile). (10 Marks)
- c. With a neat diagram, explain the construction and features of the two types of photonic crystal fibers (PCFs). (06 Marks)

Module-2

- 3 a. Discuss the absorption losses due to the materials of silica glass fibers. (06 Marks)
- b. Draw a neat diagram that represents the fiber bending loss and briefly explain the phenomenon of bending loss along with the expressions for the critical value of radius of curvature of fiber bend. How such bending losses can be reduced? (08 Marks)
- c. Write a brief note on mechanical misalignments at the joint between two optical fibers with appropriate simple diagrams. (06 Marks)

OR

- 4 a. With a neat set up diagram, explain the fusion splicing technique of optical fibers. Mention any two disadvantages of this technique. (07 Marks)
- b. Briefly explain any six principal features and requirements of a good fiber connector. (06 Marks)
- c. A 32×32 port multimode fiber transmissive star coupler has 1 mW of optical power launched into a single input port. The average optical power measured at each output port is $14 \mu W$. Calculate the total loss incurred by the star coupler and the average insertion loss through the coupler. (07 Marks)

Module-3

- 5 a. With a neat diagram, explain the construction and optical emission features of a surface emitting LED structure. (07 Marks)
- b. Mention any four difference between LEDs and LASER diodes. (04 Marks)
- c. Starting from rate equations derive an expression for the total number of photon emission from a LASER diode (i.e expression for stimulated photon emission plus spontaneous photon emission). (09 Marks)

OR

- 6 a. Mention any five performance requirements of a photo detector to be used in an optical receiver. (05 Marks)
- b. 6×10^6 photons at a wavelength of 1300 nm fall on an InGaAs photo-detector. An average of 5.4×10^6 electron-hole pairs are generated. Calculate :
 - i) The quantum efficiency η
 - ii) Responsivity R of the photo-detector. (04 Marks)
- c. Draw the neat block diagram of a typical digital optical fiber transmission-reception link along with optical and electrical pulse signals at different stages of the link. Explain the functions of the different blocks involved in that link. (11 Marks)

Module-4

- 7 a. Explain the operational principles and implementation of a WDM optical network with a neat schematic. (06 Marks)
- b. Explain the construction and working of a dielectric thin film optical filter. (06 Marks)
- c. With appropriate diagrams, explain the construction and operation of reflection and transmission type diffraction gratings. (08 Marks)

OR

- 8 a. With a neat diagram, explain the operation of a MEMS technology based actuation mechanism. (06 Marks)
- b. Explain the construction and working an optical isolator with neat diagrams. (06 Marks)
- c. Based on the general applications, explain the three types of optical amplifiers with relevant diagrams. (08 Marks)

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Module-5

- 9 a. What are the four basic functions performed by an optical packet switch? Show the overall structural format of a typical packet used in the optical packet switched network and briefly explain. (07 Marks)
- b. With a neat diagram, explain the optical circuit switched network. (06 Marks)
- c. Briefly explain each of the seven layers of OSI reference model in terms of the functions performed. (07 Marks)

OR

- 10 a. With a neat diagram, explain the optical public telecommunication network hierarchy. (07 Marks)
- b. Show the structure of a metropolitan area network and explain. (06 Marks)
- c. Briefly explain the generic Optical Label Switched (OLS) network configuration with a neat block diagram. (07 Marks)