17EC82

★Eighth Semester B.E. Degree Examination, July/August 2021
Fiber Optics and Networks

Time: 3 hrs.   Max. Marks:100

Note: *Answer any FIVE full questions.*

1   a.   Outline any light advantages of optical fibers over copper wires or coaxial cables that are used in communication links as transmission media. **(08 Marks)**
    b.   Define Numerical Aperture(NA) and what is its significance. With an optical ray diagram and by derivation relate NA and core-cladding refractive indices as well as NA and relative refractive index Δ. **(08 Marks)**
    c.   With a simple block diagram, briefly explain the digital optical communication link that employs optical fiber. **(04 Marks)**

2   a.   With neat sketches of the refractive index profile and light ray transmissions, explain the features of : i) multimode step index fiber ii) single mode step index fiber iii) multimode graded index fiber (parabolic RI profile). **(11 Marks)**
    b.   A multimode step index fiber with core diameter of $80\,\mu m$ and a relative index difference of 1.5% is operating at a wave length of $0.85\,\mu m$. If core RI is 1.48, find :
    i) the normalized frequency (or V number for the fiber) ii) the number of modes guided by the fiber. **(04 Marks)**
    c.   Compare the meridional optical rays and skew optical rays in an optical fiber. **(05 Marks)**

3   a.   The mean optical power launched into a fiber of length 8kms is 120 μW and the mean optical power at the fiber output end is 3 μW. Find :
    i)   The overall signal attenuation in dB without any connectors or splices.
    ii) The signal attenuation per kilometer for the fiber
    iii) The overall signal attenuation for a 10 km optical link using the same type of fiber with splices at 1 km intervals, each giving an attenuation of 1dB. **(06 Marks)**
    b.   Explain the phenomena of : i) material absorption and ii) linear scattering in optical fibers that lead to losses of optical signals. **(10 Marks)**
    c.   With a neat diagram, explain the technique of fusion splice for optical fibers. **(04 Marks)**

4   a.   Outline any six principal feature requirements of a good optical fiber connector. **(06 Marks)**
    b.   With a neat diagram of illustrative schematic, briefly explain the basic principle of operation and three advantages of expanded beam connectors. **(07 Marks)**
    c.   A 32 × 32 port multimode fiber transmissive star coupler has 1mW of optical power launched into a single input port. The average optical power at each output port is $14\mu W$. Find the total loss incurred by the star coupler and the average insertion loss through the coupler. **(07 Marks)**

5   a.   With a neat schematic explain the structure and features of a high radiance surface emitting LED. **(08 Marks)**
    b.   Explain briefly the three key photon transition processes involved in laser action. **(03 Marks)**
    c.   Show the derivation of the mathematical expression that estimates the amount of photon emissions per unit volume, starting from the two rate equations of laser diode. **(09 Marks)**

6 a. With relevant diagrams, explain the principles of conversion of optical signal into electrical signal by a PIN photodatector. **(08 Marks)**
   b. What are the three principal noises associated with photodetectors? Briefly explain how they originate. **(06 Marks)**
   c. Explain the operation of a digital optical receiver with a block diagram showing basic sections. **(06 Marks)**

7 a. With a neat block diagram, explain the operational principles and implementation of a WDM optical network. **(06 Marks)**
   b. Explain the construction and working of an optical isolator. **(06 Marks)**
   c. Based on the general applications, explain the three types of optical amplifiers with relevant block diagrams. **(08 Marks)**

8 a. Explain the construction and working of a dielectric thin film optical filter. **(06 Marks)**
   b. With relevant diagrams, explain the construction and operation of reflection and transmission type diffraction gratings. **(08 Marks)**
   c. With neat diagram, explain the operation of a MEMS technology based actuation mechanism. **(06 Marks)**

9 a. With a neat diagram, explain the optical public telecommunication network hierarchy. **(07 Marks)**
   b. With neat diagram, explain the optical circuit switched network. **(06 Marks)**
   c. Briefly explain each of the seven layers of OSI reference model. **(07 Marks)**

10 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. Show the structure of a metropolitan area network and explain. **(06 Marks)**
    c. With a neat block diagram, briefly explain the generic Optical Label Switched (OLS) network configuration. **(07 Marks)**

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