

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), November-December 2014

B. Tech in Electronics and Communication Engineering, Semester VII

Roll No.....

Optical Fiber Communication ECE-723

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark)

10

- i. The mechanical splice is best suited for
 - (a) Quicker installation under ideal condition
 - (b) Minimum attenuation losses
 - (c) Field services conditions
 - (d) Situations in which cost of equipment is not a factor
- ii. Loss comparisons between fusion splices and mechanical splices are
 - (a) 1:10
 - (b) 10:1
 - (c) 20:1
 - (d) 1:20
- iii. When connector losses, splice losses, and coupler losses are added, what is the coupling factor?
 - (a) Source power
 - (b) Fiber attenuation
 - (c) Connector and splice losses
 - (d) Detector sensitivity
- iv. An LED with an external quantum efficiency of 0.012 is coupled to an optical fiber of $NA = 0.15$ (with air between them) what is the overall source fiber coupling efficiency
 - (a) 1.8×10^{-4}
 - (b) 2.7×10^{-4}
 - (c) 3.2×10^{-4}
 - (d) 7.8×10^{-3}
- v. The optical fibers with different diameters are to be spliced, which of the following mechanical splices will be most suitable?
 - (a) Sung tube splice
 - (b) Loose tube splice
 - (c) Spring-groove splice
 - (d) V-groove splice
- VI. The following material is more suitable for making a p-n diode
 - (a) A direct band gap semiconductor
 - (b) A indirect band gap semiconductor
 - (c) A metal
 - (d) An insulator
- VII. Which of the following is an inherent property of an optical signal and can not be eliminated even in principle
 - (a) Thermal noise

- (b) Shot noise
 - (c) Environmental noise
 - (d) Background noise
- VIII. Practically in order to create an electron-hole pair in a p-n diode the energy of the incident photon should be
- (a) Less than E_g
 - (b) Equal to E_g
 - (c) Greater than E_g
 - (d) Much greater than E_g
- IX. Which of the following measurands can change the refractive index of a silica based fiber
- (a) Pressure
 - (b) Temperature
 - (c) Acoustic wave
 - (d) All of these
- X. As light is coupled in a multiport reflective device, the power is reduced by
- (a) 1.5 dB (b) 0.1 dB (c) 0.5 dB (d) 0.001 dB

- Q.2 Short answer type questions (4 questions @ 2.5 marks) 10
- I. V-groove splice technique
 - II. Spring-groove (springgroove) splice technique
 - III. Resonant cavity LED
 - IV. Superluminescent LED
- Q.3A Describe with the help of simple ray diagrams 05
- (a) The multimode step index fiber;
 - (b) The single mode step index fiber
- Compare the advantages and disadvantages of these two types of fiber for use as an optical channel.
- Q.3B Discuss the principles of operation of the two major categories of demountable optical fiber connectors. Describe in detail a common technique for achieving a butt-jointed fiber connector 05
- Q.4A Describe the operation of the silicon Reach through Avalanche Photodiode (RAPD) with outline the advantages and drawbacks with the use of the RAPD as a detector for optical fiber communications. 05
- Q.4B Describe in detail wavelength division multiplexing (WDM) couplers with merits and drawbacks associated with it ? 05
- Q.5A Describe with the add of a suitable diagram, the shadow method used for the on-line measurement of the outer diameter of an optical fiber. 05
- Q.5B Explain the optical return loss (ORL) measurement procedure based on the optical continuous wave reflectometer. Discuss the need for the use of an ORL test meter instead of using an OTDR. 05
- Q.6A Outline the major design criteria of an optical fiber power meter for use in the 05

field. Suggest any problems associated with the field measurements using such a device.

- Q.6B Pulse dispersion measurements are taken over a 1.2 km length of partially graded multimode fiber. The 3 dB widths of the optical input pulses are 300 ps, and the corresponding 3 dB widths for the output pulses are found to be 12.6 ns. Assuming the pulse shapes and fiber impulse response are Gaussian calculate:

- (a) The 3 dB broadening for the fiber in ns km⁻¹
- (b) The fiber bandwidth-length product

OR

- Q.6B An He-Ne laser operating at a wavelength of 0.63 μm was used with a solar cell cube to measure the scattering loss in a multimode fiber sample. With a constant optical output power the reading from the solar cell cube was 6.14 nV. The optical power measurement at the cube without scattering was 153.38 μV. The length of the fiber in the cube was 2.92 cm. Determine the loss due to scattering in dB km⁻¹ for the fiber at a wavelength of 0.63 μm.

- Q.7A Indicate the major advantages of vapor phase deposition in the preparation of glasses for optical fibers. Briefly describe the various vapor phase techniques currently in use.

- Q.7B The quantum efficiency of a particular silicon RAPD is 75% for the detection of radiation at wavelength of 0.85 μm. When the incident optical power is 0.6 μW, the output current from the device (after avalanche gain) is 11 μA. Determine the multiplication factor of the photodiode under these conditions.

OR

- Q.7B Define the noise equivalent power (NEP) for a photodetector. A silicon *p-i-n* photodiode with active dimensions 10 μm has a specific detectivity of 7×10¹⁰ mHz^{1/2}W⁻¹ when operating at wavelength of 0.85 μm. The device quantum efficiency at this wavelength is 64%. Assuming that it is the dominant noise source, calculate the dark current over a 1 Hz bandwidth in the device. Assume $h = 6.626 \times 10^{-34}$, $c = 2.998 \times 10^8$ m/s.

- Q.8 Describe the techniques employed and the fiber structures utilized to provide
- (a) Dispersion-shifted single-mode fibers
 - (b) Dispersion-flattened single-mode fibers

A 32 X 32 port multimode fiber transmissive star coupler has 1 mW of optical power launched into a single input port. The average measured optical power at each output port is 14 μW. Calculate the total loss incurred by the star coupler and the average insertion loss through the device.

- Q.9A Compare and contrast two simple technique used for the measurement of the numerical aperture of optical fibers.

Numerical aperture measurements are performed on an optical fiber. The angular limit of the far-field pattern is found to be 26.1° when the fiber is rotated from a center zero point. The far-field pattern is then displayed on a screen where its size is measured as 16.7 cm. Determine the numerical aperture for the fiber and the distance of the fiber output end face from the screen.

- Q.9B Describe in detail wavelength division multiplexing (WDM) couplers with

merits and drawbacks associated with it ?

Estimate the number of photons per bit obtained with an optical coherent WDM passive star network, which is operating from the shortest wavelength of $1.5 \mu\text{m}$ with an optical wavelength of 100 nm , when the transmitter powers are 0 dBm . Comment on the result.

OR

- Q.9B A 64×64 port transmissive star coupler has 1.6 mW of optical power launched into a single input port. If the device exhibits an excess loss of 3.90 dB , determine the total loss through the device and the average optical power level that would be expected at each output port. 10