Registration No : | | | | | | | | | | |

Total Number of Pages : 02 **B.Tech**
PET5J001

5th Semester Regular / Back Examination 2018-19
FIBER OPTICS & OPTOELECTRONICS DEVICES
BRANCH : ECE, ETC
Time : 3 Hours
Max Marks : 100
Q.CODE : E307

Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.
The figures in the right hand margin indicate marks.

Part- I

Q1 Short Answer Type Questions (Answer All-10) **(2 x 10)**

a) Define MFD.? How it is related to V parameter?
b) Find the capacity of a channel that operates between 6 MHz to 8 MHz, having signal-to-noise ratio 40 dB.
c) Draw the schematic diagram for a fiber drawing apparatus.
d) What are the difference between intramodal dispersion and intermodal dispersion?
e) What is transparency value? What are its significance in modulation response of ILD?
f) A p-n photodiode has quantum efficiency of 50 % at λ=0.92μm.Calculate the responsivity at this wavelength.
g) Compare and contrast between surface and edge emitting LEDs.
h) What is meant by $p^{+}\pi pn+$ structure?
i) What is quantum limit? How the sensitivity and quantum limit are related?
j) What is the difference between a regenerator and an optical amplifier? Which optical amplifier is most suitable for multichannel bidirectional operation?

Part- II

Q2 Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) **(6 x 8)**

a) Differentiate between step index fiber and graded index fiber, single mode fiber and multimode fiber. Draw the schematic diagram to represent the structural comparison of conventional single mode, multimode step index and multimode graded index fiber.
b) Define the normalized frequency for an optical fiber and explain its use in the determination of the number of guided modes propagating within a step index fiber.
A step index fiber in air has a numerical aperture of 0.12, a core refractive index of 1.45 and a core diameter of 60 μm. Determine the normalized frequency for the fiber when light at a wavelength of 0.90 μm is transmitted. Further, estimate the number of guided modes propagating in the fiber.
c) A 20 km optical link consists of multimode step index fiber with a core refractive index of 1.48 and a relative refractive index difference of 1%. Estimate,
   i. the delay difference between the slowest and fastest modes at the fiber output;
   ii. the rms pulse broadening due to intermodal dispersion on the link;
   iii. the maximum bit rate that may be obtained without substantial errors on the link assuming only intermodal dispersion;
   iv. the bandwidth–length product corresponding to (iii).
d) With suitable schematic diagram explain the distributed feedback laser in comparison with the Fabry–Pérot laser.
e) Discuss the various lensing schemes for coupling improvement.
f) What are principal design requirements of a good connectors? Briefly explain different types of connector.
g) Derive expressions for the SNR of both PIN and APD considering all noise sources.

h) A digital optical fiber communication system operating at a wavelength of 1 μm requires a maximum bit-error-rate of 10^{-10}. Determine:

i. the theoretical quantum limit at the receiver in terms of the quantum efficiency of the detector and the energy of an incident photon;
ii. the minimum incident optical power required at the detector in order to achieve the above bit-error-rate when the system is employing ideal binary signaling at 10 Mbit s^{-1}, and assuming the detector is ideal.

i) A silicon p–i–n photodiode has a quantum efficiency of 65% at a wavelength of 0.8 μm. Determine :

i. the mean photocurrent when the detector is illuminated at a wavelength of 0.8 μm with 5 μW of optical power
ii. the rms quantum noise current in a post-detection bandwidth of 20 MHz
iii. the SNR in dB, when the mean photocurrent is the signal.

j) Discuss the operation of Raman-Nath modulatorusing suitable diagram.

A typical acoustic-optic cell of a Raman-Nath modulator contains water. A piezoelectric crystal bonded to the cell generates acoustic wave of frequency 5.2 MHz in water. The velocity of the acoustic wave in water is 1490 ms^{-1} and the thickness of the cell is 1 cm. if a He-Ne laser beam(λ = 633 nm) is incident on the cell, calculate the angle between the first order diffracted beam and the direct beam. (Refractive index for water = 1.33)

k) Write the various amplifier structures and their corresponding operating regions. For a semiconductor optical amplifier, derive the small-signal gain per unit length.

l) A SOA has uncoated facet reflectiveness of 20% and a single pass gain of 5 dB. The device has an active region of length 300 μm, a mode spacing of 1.2 nm, and a peak gain wavelength of 1.55 μm. Calculate the refractive index of the active region and the spectral bandwidth of the amplifier.

Part-III

Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a)** Explain the concept of electromagnetic modes in relation to a planar optical waveguide. Discuss the modifications that may be made to electromagnetic mode theory in a planar waveguide in order to describe optical propagation in a cylindrical fiber. **(16)**

b) What are the criteria to select fiber materials? Discuss the different types of fiber materials.

Q4 **a)** Derive the threshold condition for laser action. **(16)**

b) On what factors does the gain coefficient of a semiconductor laser depend?

c) Calculate the maximum allowed length of the active region for single mode operation of a DH InGaAsP/InP ILD emitting at 1.3 μm. Assume that the refractive index of active region is 3.5.

Q5 **a)** What are the basic requirements to be a good photo detector? **(16)**

b) Draw and compare the construction and characteristics of p-n diode, p-i-n diode and avalanche photo diode.

c) Is it possible to make these three types of photodiodes using the same semiconductor?

Q6 **a)** Describe in detail the amplification mechanism of EDFA. **(16)**

b) Discuss the EDFA architecture.

c) Find the maximum possible EDFA output power.