B.TECH/ ECE/6TH SEM/ECEN 3241/2018

FIBER OPTIC COMMUNICATION
(ECEN 3241)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) A step index fiber has core with a refractive index of 1.48 and cladding with refractive index of 1.46. It is placed in water (refractive index 1.33). The acceptance angle of the fiber will be
(a) 100 (b)150 (c)200 (d)250.

(ii) The typical relative refractive index difference for an optical fiber is 1%. Estimate the numerical aperture when core index is1.46
(a) 0.56 (b) 0.21 (c) 0.34 (d) 0.70.

(iii) An impulse is launched into one end of the 40km long optical fiber with a rated total dispersion of 20nskm-1. What will be the width of the pulse at the other end?
(a) 20ns (b) 800ns (c) 300ns (d) 600ns.

(iv) Which of the following pairs are suitable for making hetero-junction?
(a) Si-Ge (b) Si-GasAs
(c) GaAs-AlAs (d) GaAs-AlGaAs.

(v) Larger temporal coherence in Laser results in
(a) narrower beam width (b) less absorbtion
(c) narrower spectral width (d) none of the above.

(vi) Ge has a bandgap of 0.67eV. What is the maximum wavelength that will be absorbed by it?
(a) 7080nm (b) 4560nm
(c) 1850nm (d) 1100nm.

(vii) At what wavelength attenuation in an optical fiber will be minimum?
(a) 1550nm (b) 850nm
(c) 1310nm (d) 1410nm.

(viii) Which wavelength is most suitable for pumping of EDFA?
(a)0.85μm (b)0.98μm (c)1.3μm (d)1.55μm.

(ix) An SOA differs from an EDFA in which of the following manners?
(a) SOA operates in electrical domain, EDFA operates in optical domain
(b) SOA is pumped electrically, EDFA is pumped optically
(c) SOA amplifies 1.3μm, EDFA amplifies 1.55μm
(d)there is no difference.

(x) In SONET, each synchronous transfer signal STS-n is composed of
(a) 2000frames (b) 4000frames
(c) 8000frames (d) 16000 frames.

Group – B

2. (a) Using simple ray theory, describe the mechanism for the transmission of light within a graded index optical fiber.

(b) Briefly discuss with the aid of a suitable diagram what is meant by the acceptance angle of an optical fiber. Show how this is related to the fiber numerical aperture and the refractive indices for the fiber core and cladding.

(c) A multimode graded index fiber has a relative refractive index difference of 1% and a core refractive index of 1.5. The number of modes propagating at a wavelength of 1.3μm is 1100. Estimate the diameter of the fiber core.

3 + (3 + 2) + 4= 12

3.(a) What is meant by OTDR?

(b) With the help of a diagram enumerate the different optical transmission windows. Draw the electric field patterns in an optical fiber for mode number m=0,1,2.

(c) A step index fiber supports the propagation of 500 modes. The core axis refractive index is 1.46 and the core diameter is 75 mm. If the wavelength of light propagating through the fiber is 1.3 mm, calculate
(i) the relative refractive index difference of the fiber
(ii) the maximum diameter of the fiber core which would give single-mode operation at the same wavelength.

2 + (2 + 3) + 5= 12

Group – C

4. (a) Describe the working principle of surface emitting LED with a suitable diagram.

(b) A Burrus type p-n GaAs (r.i. of 3.6 and band gap 1.43 eV) LED is coupled to a SIF using epoxy resin (r.i. of 1.5). The radiative and non-radiative recombination life times are 50ns and 100ns respectively. The LED is forward biased with a current of 150 mA and a voltage of 2V. Estimate (i) internal quantum efficiency, (ii) internal power efficiency (iii) external quantum efficiency and (iv) external power efficiency.

6 + 6 = 12

5. (a) What is population inversion? Find the threshold condition for lasing operation.

(b) A double heterostructure GaAs/GaAlAs ILD has a cavity length of 0.5mm, and effective loss coefficient α_{eff} of 1.55mm^{-1}, confinement factor Γ of 0.8, and uncoated facet reflectivities of 0.35. Calculate the reduction in the threshold gain coefficient when the reflectivity of one of the facets is increased to 1.

(c) Explain the working principle of distributed feedback laser with a suitable diagram.

(2 + 4) + 3 +3 = 12

Group – D

6. (a) Prove that $R = \frac{\eta e \lambda}{hc}$ where R= responsivity, e=electronic charge, h= plank's constant, λ=wavelength, c=velocity of light and η = quantum efficiency.

(b) Explain the working principle of SOA with a suitable diagram.

(c) Draw the block diagram of a WDM system.

4 + 5 + 3 = 12

7. (a) Explain the working principle of p-i-n photodiode with a diagram.

(b) Explain the principle operation of Fabry Perot filter.

(c) When 3×1011 photons each with a wavelength of 0.85μm are incident on a photodiode, on an average 1.2×10^{11} electrons are collected at the terminals of the device. Determine the quantum efficiency and the responsivity of the photodiode at 0.85μm.

5 + 3 + 4 = 12

Group – E

8. (a) What are the different types of stations in FDDI? Explain the frame structure of the FDDI frame.

(b) Describe the physical layers of SONET.

(c) What is SDH?

(4 + 2) + 4 + 2 = 12

9. Write short notes on any three of the following:
(i) Dispersion flattened optical fiber
(ii) ISDN
(iii) Step index optical fiber.
(iv) EDFA

3 × 4 = 12