OPTO ELECTRONICS AND FIBRE OPTICS
(AEIE 3233)

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) Which of the following is not suitable for making an LED?
(a) GaAs (b) Si
(c) InGaAsP (d) GaAlAs.

(ii) Which fiber is preferred for long distance communication?
(a) Step index single mode fiber
(b) Graded index multimode fiber
(c) Step index multimode fiber
(d) Graded index fiber.

(iii) Light is guided within the core of a step index fiber by
(a) refraction at the core –air interface
(b) total internal reflection at the core cladding interface
(c) total internal reflection at the outer surface of the cladding
(d) change in speed of light within the core.

(iv) Which of the following is an example of a wavelength modulated sensor?
(a) Micro bend sensor (b) Fiber optic gyroscope
(c) A fluorescence temperature sensor (d) All of these.

(v) A photoconducting detector can be constructed from
(a) an intrinsic semiconductor
(b) an extrinsic semiconductor
(c) polycrystalline material
(d) all of these.

(vi) At which wavelength the silica fiber has minimum loss and dispersion?
(a) 0.85μm (b) 1.7μm (c) 1.1μm (d) 1.3μm.

(vii) The core of an optical fiber has a
(a) lower refracted index than air
(b) lower refractive index than the cladding
(c) higher refractive index than the cladding
(d) similar refractive index with the cladding.

(viii) Nd^{3+}: YAG laser is
(a) solid state laser (b) a molecular laser
(c) dye laser (d) semiconductor laser.

(ix) What is the wavelength value of CO2 laser used in laser beam machining?
(a) 0.16 μm (b) 1.6 μm
(c) 10.6 μm (d) 106 μm.

(x) If two optical fibers with different diameter are to be spliced, which of the following mechanical splices will be most suitable?
(a) Snug tube splice (b) Loose tube splice
(c) Spring groove splice (d) V-groove splice.

Group – B

2. (a) Explain direct band gap type and indirect band gap type of semiconductors. Give at least two examples of each. Which of these are suitable for fabricating LEDs?

(b) Write short note on any two:
(i) Optoisolator
(ii) LDR
(iii) Photo-transistor.

(3 + 2 + 1) + (2 × 3) = 12

3. (a) Mention few photo detector materials and their properties. What is electroluminescence?

(b) Write short note on any one:
(i) Photo conducting effect
(ii) Photo voltaic effect.

(3 + 4) + 5 = 12

Group – C

4. (a) What is meant by heterojunction? Write the basic principle of confinement of carriers in heterojunction LED.

(b) The radiative and non-radiative recombination lifetime of minority carriers in active region of double heterojunction LED are 50ns and 100ns respectively. Determine the total carrier life time and the optical power generated internally within the device when the peak emission wavelength is 0.85μm at a drive current of 40mA.

(5 + 3) + 4 = 12

5. (a) Distinguish between a p-n diode, a p-i-n diode, and an APD. Is it possible to make these three types of photodiodes using the same semiconductor? Explain your answer with proper logic.

(b) A p-i-n photodiode, on an average, generates one electron-hole pair per two incident photons at a wavelength of 0.85 μm. Assuming all the photo-generated electrons to be collected, calculate (i) the quantum efficiency of the diode (ii) the maximum possible band gap energy (in eV) of the semiconductor, assuming the incident wavelength to be long cut-off; and (iii) the mean output photocurrent when the incident optical power is 10 μW.

(5 + 1 + 3) + (1 + 1 + 1) = 12

Group – D

6. (a) What is stimulated emission? Explain optical feedback and laser oscillation.

(b) Compare LASER and LED as source in optical fiber communication system.

(2 + 5) + 5 = 12

7. (a) Describe Laser Machining with proper diagram. What applications are best suited for Laser Machining? What are the advantages and disadvantages of Laser Machining over other processes?

(b) An injection laser has GaAs active region with band gap energy 1.43eV. Find the wavelength of the optical emission and determine its line width in Hz, if measured spectral width is 0.1nm.

(4 + 3 + 3) + 2 = 12

Group – E

8. (a) Describe the structures of different types of optical fibers with ray paths. What is the approximate diameter of an optical fiber in each case?

(b) The average optical power launched into a 10 km length of fiber is 100 μW and the average output power is 2.5 μW. Calculate (i) the signal attenuation in decibels through the fiber, assuming that there are no connectors or splices (ii) the signal attenuation per km of the fiber, (iii) overall signal attenuation for the 11 km optical link using the same fiber with three splices each having an attenuation of 0.8 dB and (iv) numerical value of the ratio between input and output power.

(4 + 2) + (2 + 2 + 1 + 1) = 12

9. (a) What are the three important mechanisms that are responsible for absorption losses in signal through an optical fiber? Explain in brief.

(b) Write short note on any one:
(i) Optical fiber flow sensor
(ii) Optical fiber temperature sensor.

6 + 6 = 12