

**B.TECH/AEIE/6<sup>TH</sup> SEM/AEIE 3233/2018**  
**OPTO ELECTRONICS & 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 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.
- (ii) At which wavelength the silica fiber has minimum loss and dispersion?  
(a) 0.85μm (b) 1.7μm (c) 1.1μm (d) 1.3μm.
- (iii) The core of an optical fiber has a  
(a) lower refractive index than air  
(b) lower refractive index than the cladding  
(c) higher refractive index than the cladding  
(d) similar refractive index with the cladding.
- (iv) What is the wavelength value of CO<sub>2</sub> laser used in Laser beam machining?  
(a) 0.16μm (b) 1.6μm (c) 10.6μm (d) 106μm
- (v) Which of the following pairs are suitable for making a heterojunction?  
(a) Si and Ge (b) Si and GaAs  
(c) Ge and GaAs (d) GaAs and GaAlAs.

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- (vi) Light guided within the core of a step index fiber suffers  
(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 within the core.
- (vii) A photo conducting detector can be constructed from  
(a) an intrinsic semiconductor (b) an extrinsic semiconductor  
(c) polycrystalline material (d) all of the above.
- (viii) What kind of change can be measured by a-fiber interferometer?  
(a) Intensity (b) Phase  
(c) Wavelength shift (d) All of the above.
- (ix) Nd<sup>3+</sup>:YAG laser is  
(a) solid state laser (b) a molecular laser  
(c) dye laser (d) semiconductor laser
- (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 the detection process in a p-n photodiode. Compare the device with p-i-n photodiode.  
(b) Photons of wavelength 0.90μm are incident on a p-n photo diode at a rate of  $5 \times 10^{10} \text{ s}^{-1}$  and on an average, the electrons are collected at the terminal of the diode at the rate of  $2 \times 10^{10} \text{ s}^{-1}$ .  
Calculate  
(i) quantum efficiency  
(ii) the responsivity of the diode at this wavelength?  
**(3 + 3)+(3 + 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) Discuss the important requirements of an optical source for use in optical communication. Give the spectrum of a few of them.
- (b) A LED is forward biased with a current of 100mA and a voltage of 2 V, and the emitted photon possess energy 1.59 eV. Assuming that the refractive indices of the core and cladding of the optical fiber are 1.58 and 1.43, respectively, calculate
- the internal power efficiency of the device
  - external power efficiency of the diode, if it is emitting in air
  - overall source fiber coupling and the optical loss (in dB).

$$(4+2) + (2+2+2) = 12$$

5. (a) Explain with relevant diagram the basic principle of confinement of carriers and optical power in the active region of a double heterojunction LED.
- (b) A double heterojunction InGaAsP-LED operating at 1310 nm has radiative and non-radiative recombination times of 30 ns and 100 ns, respectively. The injected current is 40 mA. Calculate
- the internal quantum efficiency of the LED and
  - bulk recombination life time internal power level.

$$6 + (3+3) = 12$$

**Group – D**

6. (a) Explain with necessary diagrams three processes of absorption, spontaneous emission and stimulated emission in a two-level energy system.
- (b) A GaAs injection laser with refractive index 3.6 has a cavity length of 500μm and the loss coefficient is 20cm<sup>-1</sup>. The measured differential quantum efficiency is 45%. Calculate the internal quantum efficiency of semiconductor laser.
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) If the step index fiber has a core of refractive index 1.5, a cladding of refractive index 1.48 and a core diameter of 100μm, calculate
- NA of the fiber
  - Angle  $\alpha_m$ ,  $\theta_m$ ,  $\phi_c$
  - Pulse broadening per unit length due to multipath dispersion.
9. (a) Explain in brief Rayleigh scattering mechanism.
- (b) What are the three important mechanisms that are responsible for absorption losses in signal through an optical fiber? Explain in brief.
- (c) Write short note on any one:
- Optical fiber flow sensor
  - Optical fiber temperature sensor.

$$(4+2) + (2+2+2) = 12$$

$$3 + 4 + 5 = 12$$