

**3 (Sem-5) ELE M 2**

**2 0 1 6**

**ELECTRONICS**

**( Major )**

Paper : 5.2

**( Optoelectronics )**

Full Marks : 60

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

1. Choose the correct answer :  $1 \times 8 = 8$

(a) Which one of the following materials is used to fabricate LED that emits blue color light?

(i) GaN doped with Zn

(ii) SiC doped with Be

(iii) GaAs doped with Si

(iv) None of the above

(b) Beyond long wavelength cutoff of a photodiode, incoming light is

(i) transparent to photodiode material

(ii) absorbed by photodiode material

(iii) reflected by photodiode material

(iv) None of the above

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( Turn Over )

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- (c) Lasers work based on phenomenon of
- (i) spontaneous emission
  - (ii) stimulated emission
  - (iii) radiative recombination of carriers
  - (iv) None of the above
- (d) Light waves propagate inside optical fibers by virtue of
- (i) reflection
  - (ii) total internal reflection
  - (iii) diffraction
  - (iv) None of the above
- (e) The energy of a photon of wavelength  $0.75 \mu\text{m}$  is ( $h = 6.62 \times 10^{-34}$  J-s,  $c = 3 \times 10^8$  m/s)
- (i)  $1.6 \times 10^{-19}$  J
  - (ii)  $2 \times 10^{-19}$  J
  - (iii)  $2.65 \times 10^{-19}$  J
  - (iv) None of the above
- (f) Thermal noise becomes quite significant during operation of
- (i) visible light detecting photodiodes
  - (ii) long wavelength photodiodes
  - (iii) short wavelength photodiodes
  - (iv) None of the above

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- (g) Q-factor of laser cavity resonator is
- (i) very low
  - (ii) very high
  - (iii) moderately high
  - (iv) None of the above
- (h) Spectral broadening of LED increases with
- (i) decrease of drive current
  - (ii) increase of temperature
  - (iii) decrease of temperature
  - (iv) None of the above

2. Answer any six of the following :  $2 \times 6 = 12$

- (a) Mention the various processes by which radiative recombination of electron and hole occurs in semiconductor.
- (b) What do you mean by Stokes shift?
- (c) Draw  $E-K$  energy band diagrams of direct and indirect semiconductors.
- (d) Mention the various optical processes involved during interaction of light with semiconductors.

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- (e) What do you mean by population inversion in lasers?
- (f) What is dark current?
- (g) Define modulation bandwidth of an LED.
- (h) Define numerical aperture of optical fiber.

3. Answer any four of the following :  $5 \times 4 = 20$

- (a) Explain the light emission mechanism of organic LED with energy-level diagram.
- (b) Explain the important steps involved in operation of Q-switching lasers.
- (c) Explain the operation of He-Ne laser with energy-level diagram.
- (d) A photodiode has 70% quantum efficiency when photons with energy  $2.2 \times 10^{-19}$  J incident on it. Determine the wavelength of the photon and responsivity of the photodiode.

$$h = 6.62 \times 10^{-34} \text{ J-s}, 1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

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- (e) Give some applications of laser. Calculate the ratio of stimulated emission rate to spontaneous emission rate for a laser at  $T = 2000$  K.

Given :

$$\lambda = 1.45, k = 1.38 \times 10^{-23} \text{ J/K}$$

$$c = 3 \times 10^8 \text{ m/s}, h = 6.62 \times 10^{-34} \text{ J-s}$$

The symbols have their usual meaning.

$$3+2=5$$

- (f) The refractive indexes of core and cladding of a step index multimode optical fiber are 1.426 and 1.410 respectively. Determine the acceptance angle and numerical aperture of the fiber. How does a single-mode optical fiber provide lesser pulse dispersion?

$$2+3=5$$

4. Write short notes on any two of the following :  $10 \times 2 = 20$

- (a) Electrooptic modulation of light
- (b) Laser threshold condition
- (c) Luminescence

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