



Name :

Roll No. :

Invigilator's Signature :

**CS/B.Tech (EIE-N)/SEM-6/EI-602/2010
2010**

OPTO ELECTRONICS & OPTICAL INSTRUMENTATION

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

- i) The dark current in the photodiode is actually
 - a) forward current through the junction
 - b) reverse saturation current
 - c) basically an output radiation
 - d) none of these.
- ii) A step index fibre has a core with a refractive index of 1.50 and a cladding with refractive index of 1.46. The fibre is placed in water (*r.i.* = 1.33). The acceptance angle of the fibre will be
 - a) 10°
 - b) 15°
 - c) 20°
 - d) 25° .



iii) f -number of a lens is defined as

- a) the ratio of focal length of the lens and image size
- b) the ratio of image distance and object distance
- c) the product of image distance and object distance
- d) the ratio of focal length of the lens and diameter of the stop.

iv) Aplanatic lens means free from the defects of

- a) spherical aberration b) comatic aberration
- c) both (a) & (b) d) astigmatism.

v) The colour of an LED can be changed

- a) using different band gap semiconductor
- b) by changing the doping level
- c) by increasing the applied voltage
- d) by decreasing the applied voltage.

vi) Band gap energy of a material is 1.24 eV. What is the wavelength of peak emission ?

- a) 0.75 μm b) 1.0 μm
- c) 1.24 μm d) 1.54 μm .



vii) The light travels a distance of 20 km in a medium of refractive index 1.0. The optical path of the medium will be

- a) 10 km b) 20 km
- c) 5 km d) 20 m.

viii) For a single mode operation V-parameter of an optical fibre is

- a) less than 2.404 b) more than 2.404
- c) less than 3.141 d) more than 3.141.

ix) The spectral broadening of LED is due to

- a) uncertainty property
- b) the temperature effect
- c) both (a) and (b)
- d) none of these.

x) Amongst different types of fibres, single-mode step-index fibre has

- a) highest data rate
- b) lowest attenuation
- c) highest thickness
- d) both (a) and (b).



xi) Which of the following pairs is suitable for making a heterojunction ?

- a) Si and Ge b) Si and GaAs
- c) GaAs and AlAs d) GaAs and GaAlAs.

xii) Which of the following fibres is suitable for wavelength-division multiplexing of signals ?

- a) Dispersion-optimized
- b) Dispersion-shifted
- c) Dispersion-flattened
- d) Any fibre.

GROUP – B

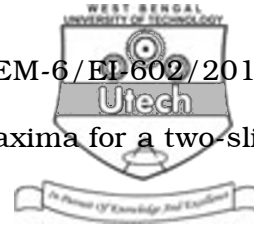
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

- 2. Prove the Gaussian formula for a spherical lens.
- 3. What are meant by dispersion and angular dispersion ?

A horizontal ray of light passes through a prism of RI ~ 1.50 and prism angle 4° and it strikes a vertical mirror. Through what angle must the mirror be rotated if after reflection the ray is to be horizontal ?

2 + 3



4. Determine the position for the principal maxima for a two-slit Fraunhofer diffraction pattern.
5. What is optocoupler ? Describe briefly its operation and utility.
6. Why is the optical resonator required in lasers ? What are the essential components of a laser ?

GROUP – C

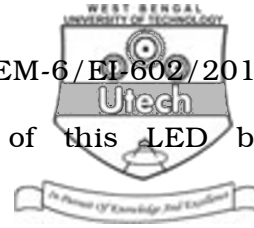
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7.
 - a) What are the causes of attenuation in optical fibres ?
 - b) Why could bending loss in single-mode fibres be severe ? What can be done to minimize this loss ?
 - c) Describe the fibre structures utilized to provide
 - i) dispersion-shifting
 - ii) dispersion-flatteningin single-mode fibres. $3 + (3 + 3) + (3 + 3)$
8.
 - a) What do you mean by multimode optical waveguide ?
 - b) Show that the number of modes (M) in a strip waveguide is directly proportional with core diameter of the waveguide.



- c) Why is pulse dispersion in step index fibre greater than graded index fibre ?
- d) Light from an LED source having $\lambda = 0.85 \mu\text{m}$ and intrinsic spectral width $\sim \Delta\lambda = 25 \text{ nm}$ is coupled through a silica fibre with material dispersion $\sim 4 \times 10^{10} / \text{m}^2$. Calculate the pulse dispersion for this system. 2 + 6 + 3 + 4
9. a) What do you mean by wave front reconstruction ? Explain, how three-dimensional object is recorded on hologram. How do we reconstruct the image from the hologram ?
- b) Explain the working principle of opto-isolator using SWP. 10 + 5
10. a) Distinguish between non-radiative and radiative recombination processes in a semiconductor.
- b) Show that the average ratio of internal quantum efficiency of direct band-gap material : the same of indirect band-gap material $\sim 10^6 : 1$.
- c) With system diagram describe briefly the operations of planar LED.



d) How can the external efficiency of this LED be improved ?

e) A GaAs LED has the following parameters :

$$D_n = 30 \text{ cm}^2/\text{V-s}, \quad P_p = 15 \text{ cm}^2/\text{V-s}, \quad N_a = 5 \times 10^{16} \text{ cm}^{-3},$$

$$N_d = 5 \times 10^{17} \text{ cm}^{-3}, \quad \tau_n = 10^{-8} \text{ s}, \quad \tau_p = 10^{-7} \text{ s}$$

Calculate the injection efficiency of the LED.

$$2 + 3 + 5 + 2 + 3$$

11. Write short notes on any *three* of the following : 3 × 5

- a) Monochromator
- b) Refractometer
- c) Spectrometer
- d) P-N junction photodetector
- e) Phototransistor.

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