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 :

$$10 \times 1 = 10$$

   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 singals ?

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 Fraunhoffer 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-flattening

      in 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 form an LED source having $\lambda = 0.85$ μm and intrinsic spectral width $\sim \Delta\lambda = 25$ nm is coupled through a silica fibre with material dispersion $\sim 4 \times 10^{10}/m^2$. 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 matrial $\sim 10^6 : 1$.

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 :

$D_n = 30$ cm^2/V – s, $P_p = 15$ cm^2/V – s, $N_a = 5 \times 10^{18}$ cm^{-3},

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