Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / B.TECH (EIE) / SEM-6 / EI-602 / 2012

2012

OPTO ELECTRONICS AND 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) Light is an electromagnetic wave-proposed by

a) Fresnel b) Young

c) Maxwell d) Planck.

ii) Which one of the following in non-dispersive medium ?

a) Monochromator b) Grating

c) Beam splitter d) None of these.

iii) The smallest separation between object and real image is

a) $d^2 > 4f$ b) $d > 4f$

c) $d < 4f$ d) $d^2 < 4f$.

iv) When microscope is in normal use where is the fine image going to form ?

a) at D = 25 cm from the eye

b) at focus of the object

c) at focus of the eye piece

d) at d < 25 cm from the eye.

v) Holography is formed mainly due to

a) interference of light b) particle nature of light

c) dual nature of light d) polarization of light.

vi) Dispersive power is independent of

a) Refractive index of the prism

b) angular dispersion of the prism

c) angle of the prism

d) none of these.

vii) The Dark Current in the Photo Diode is actually the

a) Forward current through the junction

b) Reverse saturation current

c) Basically an output radiation

d) None of these.

viii) GaAsP is a

a) Homojunction Direct Band Gap type semiconductor material

b) Single Heterojunction Direct Band Gap type semiconductor material

c) Homojunction Indirect Band Gap type semiconductor material

d) None of these.

ix) Newton formula for a single spherical surface is

a) $(x_1 x_2)^2 = (f_1 f_2)^2$ b) $x_1 + x_2 = f_1 + f_2$

c) $x_1 x_2 = f_1 f_2$ d) none of these.

x) 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.

xi) If a point source is positioned on the central or optical axis at the point F_1 infront of the convex lens, the luminous image formed is

a) Reflecting device

b) Refracting device

c) Semi transparent device

d) none of these.

xii) Which of the following is an example of an intensity-modulated sensor ?

a) A sensor based on the relative displacement of two fibres

b) A fibre-optic gyroscope

c) A Mach-Zehnder interferometer

d) All of these.

GROUP – B

(Short Answer Type Questions)

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

2. A thin convex lens is surrounded by air and the RI of the lens material is 2·5. The radii of curvatures of the lens surfaces are 25 cm and 30 cm respectively. Find the location of the image formed when an object is placed 75 cm before the lens.

3. What is numerical aperture (NA) of an optical fibre ? Derive the expression for NA in terms relative refractive index of a step-index fibre.

4. Prove that for a thin total reflection prism in air, the total deviation in path of ray depends only on the refractive index of the prism material and its refracting angle. 3 + 2

5. a) Derive the expression of quantum efficiency for a GaAs LED in terms of the life time of transitions.

   b) Explain Temporal Coherence. 3 + 2

6. a) What do you mean by Q-Switching in laser ?

   b) Calculate the ratio of the stimulated emission rate to the spontaneous emission rate for an incandescent lamp operating at a temperature of 1000 K. It may be assumed that the average operating wavelength is $0 \cdot 5$ μm. 2 + 3

GROUP – C

(Long Answer Type Questions)

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

7. a) What do you mean by 'depth of focus' in respect to a camera ? Find a relation of it with the radius of the exit pupil.

b) Mention the construction and working of a refracting astronomical telescope. Show that in the case of an astronomical telescope the magnifying power is equal to the ratio of the diameter of the objective to the diameter of the exit pupil. (2 + 4) + (4 + 5)

8. a) Describe the construction and working of a refracting astronomical telescope. Also calculate the magnifying power of this telescope system in terms of the focal lengths of the objective and the eye piece.

b) A telescope with an objective of focal length of 50 cm is used to bring into view an object 150 cm distant. When the eye piece is adjusted to form the image at infinity, the magnifying power is 5. Calculate :

(i) the focal length of the eye piece

(ii) the magnifying power of the telescope if the eye piece is adjusted to view objects at infinity.

(6 + 4) + (3 + 2)

9. a) Discuss how the population inversion is achieved in semiconductor laser.

b) Explain the term quantum efficiency and responsivity in photo detector

c) Explain the difference between skew ray and meridonial ray.

d) What is meant by acceptance angle for an optical fibre ? Show how this is related to numerical aperture.

4 + 2 + 3 + (2 + 4)

10. a) Define carrier generation rate in photo detector. How it depends on incoming photon energy ?

b) Show that, in a photodiode under photoconductive mode of operation, the photocurrent is linearly dependent of the incident optical power.

c) What are the factors that limit the speed of operation of a photodiode ?

d) Light from a GaAs laser at $h\nu \sim 1 \cdot 43\text{eV}$ impinges on a Si PIN detector with I-region~$10\,\mu\text{m}$. If the optical power of the source ~$1\text{W}/\text{cm}^2$, calculate the photocurrent density of the detector. Use α value of Si at GaAs operating wavelength ~700 cm^{-1} here.

(2 + 2) + 5 + 3 + 3

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

a) Heterojunction LED

b) Q-switching phenomena

c) P-N-Junction photodetector

d) Photo transistor

e) CO_2 LASER.