OPTICAL INSTRUMENTATION
(AEI3123)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) In a step-index fiber, meridional rays
(a) Travel along curved paths
(b) Travel along straight-line paths through the axis
(c) Do not pass through the core axis
(d) Are not guided

(ii) Skew rays in optical fibers are defined as
(a) Rays that pass through the core axis
(b) Rays that never pass through the core axis
(c) Rays that travel in cladding only
(d) Rays that follow helical paths around axis

(iii) Attenuation in single-mode fiber is mainly due to
(a) Intermodal dispersion (b) Rayleigh scattering
(c) Material defects (d) Splicing loss

(iv) Injection efficiency of an LED is defined as
(a) Ratio of photons to electrons
(b) Ratio of carriers injected into active region to total carriers
(c) Ratio of light out to input power
(d) Ratio of junction area to volume

(v) Responsively of a photodiode is defined as
(a) Current per incident optical power (b) Voltage per optical power
(c) Charge per photon (d) Power per wavelength

(vi) Differential quantum efficiency is related to
(a) Loss coefficient (b) Carrier density
(c) Energy gap (d) Photon density

(vii) Semiconductor LASER is generally
(a) Edge-emitting (b) Surface-emitting only
(c) Not suitable for optical fiber (d) Random emission

(viii) Mach–Zehnder interferometer uses
(a) Beam splitting and recombination (b) Polarization rotation
(c) Total internal reflection (d) Scattering

(ix) Fiber optic temperature sensor uses
(a) Wavelength shift in Bragg grating (b) Phase mismatch
(c) Polarization loss (d) None

(x) Electro-optic modulators rely on
(a) Change in refractive index under electric field
(b) Thermal change
(c) LED switching
(d) Population inversion

Fill in the blanks with the correct word

(xi) Multipath time dispersion is mainly observed in _____ mode fibers.

(xii) Internal quantum efficiency depends on the rate of _____ recombination.

(xiii) Stimulated emission must dominate over _____ for LASER action to occur.

(xiv) The loss caused due to mode mismatch at splices is termed as _____ loss.

(xv) The physical effect used in fiber optic current sensors is the _____ effect.

Group - B

2. (a) Explain the principle of light propagation in an optical fiber with the help of total internal reflection. *[(CO1,CO5)(Remember/LOCQ)]*
(b) Derive the expression for acceptance angle and numerical aperture of a step-index fiber. *[(CO1,CO5)(Apply/IOCQ)]*
(c) Discuss the significance of critical angle in optical fiber communication. *[(CO1) (CO5) (Analyse/HOCQ)]*

5 + 4 + 3 = 12

3. (a) Explain the concept of dispersion in optical fibers. *[(CO1,CO5)(Remember/LOCQ)]*
(b) Differentiate between intermodal (multipath) dispersion and material dispersion. *[(CO1,CO5)(Apply/IOCQ)]*
(c) Discuss how dispersion limits the bandwidth of an optical fiber link. *[(CO1,CO5)(Analyse/HOCQ)]*

5 + 4 + 3 = 12

Group - C

4. (a) Differentiate between homojunction and heterojunction LEDs. *[(CO2,CO6)(Remember/LOCQ)]*

(b) Explain the concept of carrier confinement in double heterostructure LEDs. *[(CO2,CO6)(Apply/IOCQ)]*

(c) Discuss the advantages of double heterojunction LEDs over simple LEDs. *[(CO2,CO6)(Analyse/HOCQ)*

5 + 4 + 3 = 12

5. (a) Explain the principle of optoelectronic detection in photodiodes. *[(CO2,CO6)(Remember/LOCQ)]*

(b) Derive the relation between optical absorption coefficient and photocurrent. *[(CO2,CO6)(Apply/IOCQ)]*

(c) Define responsivity of a photodetector and derive its mathematical expression. *[(CO2,CO6)(Analyse/HOCQ)]*

5 + 4 + 3 = 12

Group - D

6. (a) State and explain the fundamental characteristics of LASER. *[(CO3,CO6)(Remember/LOCQ)]*

(b) Derive Einstein's relations for emission and absorption. *[(CO3,CO6)(Apply/IOCQ)]*

(c) Explain the significance of coherence in LASER operation. *[(CO3,CO6)(Analyse/HOCQ)]*

5 + 4 + 3 = 12

7. (a) Explain LASER-based distance measurement. *[(CO3,CO6)(Remember/LOCQ)]*

(b) Describe velocity measurement using Doppler shift. *[(CO3,CO6)(Apply/IOCQ)]*

(c) Discuss atmospheric effects on LASER measurements. *[(CO3,CO6)(Analyse/HOCQ)]*

5 + 4 + 3 = 12

Group - E

8. (a) Explain the principle of intensity-modulated fiber sensors. *[(CO4,CO5)(Remember/LOCQ)]*

(b) Describe microbending-based fiber optic sensors. *[(CO4,CO5)(Apply/IOCQ)]*

(c) Discuss advantages and limitations of intensity modulation. *[(CO4,CO5)(Analyse/HOCQ)]*

5 + 4 + 3 = 12

9. (a) Explain fiber Bragg grating based temperature sensing. *[(CO4,CO5)(Remember/LOCQ)]*

(b) Discuss advantages of distributed temperature sensors. *[(CO4,CO5)(Apply/IOCQ)]*

(c) Mention applications in power systems. *[(CO4,CO5)(Analyse/HOCQ)]*

5 + 4 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	41.66	33.33	25