

OPTICAL INSTRUMENTATION
(AEIE 4126)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group - A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which multimode fiber properties help to reduce connection losses?
(a) larger core size and lower NA (b) higher NA and core size
(c) smaller core size and lower NA (d) larger core size and larger NA
- (ii) In an LED, which of the following factors affects most severely the efficiency of the diode and cannot be eliminated even in principle
(a) Fresnel reflection (b) back emission
(c) total internal reflection (d) absorption
- (iii) A step-index fiber has a core with refractive index of 1.50 and a cladding with refractive index of 1.46. Its numerical aperture is _____
(a) 0.156 (b) 0.244
(c) 0.344 (d) 0.486
- (iv) Practically, in order to create an electron hole pair, the energy of the photon should be
(a) less than E_g (b) greater than E_g
(c) equal to E_g (d) none of these
- (v) If two optical fiber with different diameter are to be spliced, which of the following mechanical splices will be most suitable?
(a) Snug tube splice (b) Loose tube splice
(c) Spring groove splice (d) V groove splice
- (vi) What fiber mechanisms weaken and distort the optical launched into the fiber?
(a) Scattering, absorption, and dispersion
(b) Scattering, absorption, and radiation
(c) Absorption, dispersion, and radiation
(d) Scattering, reflection and refraction

- (vii) If germanium has a band gap of 0.67 eV, then the minimum wavelength _____ is absorbed by it.
(a) 7080 nm (b) 4560 nm (c) 1850 nm (d) 1100 nm
- (viii) In which of the following optic fiber sensor the fiber is simply used to carry light to and from an external optical device where the sensing takes place?
(a) Extrinsic fiber optic sensor
(b) Energized fiber optic sensor
(c) All fibers are used to simply carry light to and from the external optical devices
(d) Intrinsic fiber optic sensor.
- (ix) OTDR stands for _____
(a) Optical time domain reflectometer (b) Optical transfer data rate
(c) Optical time data registers (d) None of the mentioned
- (x) On the bases of application of optic fiber sensor, which of the following is not considered to be the classification of fiber optic sensor?
(a) Biomedical/photometric sensors (b) Physical sensors
(c) Thermal sensors (d) Chemical sensors

Group- B

2. (a) What are the basic requirement of photo detector to generate current. [(CO4)(Remember/LOCQ)]
(b) Define quantum efficiency and responsivity of photodiode. Analyze it quantitatively and qualitatively. [(CO4)(Analyze/IOCQ)]
(c) The responsivity of photodiode is 0.85 A/W and the input power saturation is 1.5mW. Evaluate the Photo current if the incident light power is 1mW? [(CO4)(Evaluate/HOCQ)]
2 + (2 + 2 + 2) + 4 = 12
3. (a) What are the homojunction and heterojunction type semiconductor? [(CO3)(Remember/LOCQ)]
(b) Analyze direct and indirect bandgap type semiconductor (GaAs) with the help of E-K diagram. How it will change from one type to another? [(CO2)(Analyse/IOCQ)]
(c) If a LED is forward biased with a current of 120 mA and a voltage 1.5V and emitted photon posses energy, $E_{ph} = 1.43\text{eV}$. Evaluate a) the internal power efficiency of the device b) the external power efficiency of the device, if it is emitting in the air. Assume that the refractive indices of the core and cladding of the optical fiber are 1.5 and 1.48 respectively. [(CO3)(Evaluate/HOCQ)]
2 + (4 + 2) + 4 = 12

Group - C

4. (a) Explain the effect of source fiber coupling mismatch. [(CO1)(Understand/LOCQ)]
(b) Illustrate different type of optical fiber connector and splices with respect to maintenance of the fiber. [(CO1)(Understand/LOCQ)]
(c) A step index fiber is operating at a wavelength of 1.3 μ m with the refractive indices of core and claddings are 1.450 and 1.447, respectively. Measure the maximum acceptance angle. [(CO1)(Evaluate/HOCQ)]
4 + 6 + 2 = 12
5. (a) Discussed the extrinsic losses in the optical fiber. [(CO1) (Remember/LOCQ)]
(b) Two compatible multimode SI fibers are joint with small air gap. The fiber axes and end faces are perfectly aligned. Evaluate the refractive index of fiber core if the joint is showing the loss of 0.47 dB. [(CO1) (Evaluate/HOCQ)]
(c) Comparative analysis of different type's optical fiber with respect to their refractive index profile, number of mode propagation through optical fiber and application. [(CO1)(Analyze/IOCQ)]
3 + 3 + 6 = 12

Group - D

6. (a) What is meant by optical and electrical confinement in a semiconductor laser?
[(CO5) (Remember/LOCQ)]
(b) Graphically and mathematically analyze the optical output response of a semiconductor laser with the temperature variation. (Temperature change from 20 °C to 30 °C). [(CO5)(Analyze/IOCQ)]
(c) An injection laser has GaAs active region with band gap energy 1.43eV. Evaluate the wavelength of optical emission. [(CO5)(Evaluate/HOCQ)]
(2 + 2) + (3 + 3) + 2 = 12
7. (a) Derive an expression for the threshold of gain for laser oscillations.
[(CO5) (Remember/LOCQ)]
(b) Analyze graphically the effects of temperature on optical output of a semiconductor laser. [(CO5) (Analyze/IOCQ)]
(c) Evaluate the optical gain the threshold of a ruby laser diode having the following values. Reflection coefficient (both mirrors) =0.32, Loss coefficient=10/cm. length between two Mirrors=500 μ m. [(CO5) (Evaluate/HOCQ)]
4 + 4 + 4 = 12

Group - E

8. (a) Explain the use of micro bending in fiber optic sensor. [(CO6) (Understand/LOCQ)]

- (b) A fiber optic cable of a length of 5 km is attached to an apparatus to measure loss. The detector has then sensed output of 5 V for 5 km length. When the fiber is cut back to leave a 2 m length voltage increases to 10 V. Determine the attenuation per km. [(CO6) (Evaluate/HOCQ)]
- (c) Choose a suitable technique to measure the temperature using Fiber optic sensor. [(CO6) (Evaluate/HOCQ)]

3 + 4 + 5 = 12

9. (a) The application of pressure moves a diaphragm that makes a change in the intensity of light. Analyze this occurrence for pressure measurement. [(CO6) (Analyze/IOCQ)]
- (b) If a beam of polarized light passed through the glass in the direction of an applied magnetic force, what happens to the polarized light? [(CO6) (Remember/LOCQ)]
- (c) Explain how a prism is utilized to measure the liquid level by adopting fiber optic technique. [(CO6) (Evaluate/HOCQ)]

4 + 2 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25%	33.33%	35.42%

Course Outcome (CO):

After the completion of the course students will be able to

1. Learn the techniques of communications using optical fiber.
2. Learn the difference between direct and indirect band gap semiconductors.
3. Characterize structures and performance of LEDs and lasers.
4. Learn the structures and performance of photo detectors (like photo diode, PIN diode, APD etc).
5. Explain the techniques of measurement of distance, length, velocity, acceleration, current, voltage using laser. Formulate the structure of generalized measurement system.
6. Acquire the knowledge of different types of optical fiber sensors and their applications

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
CHE	https://classroom.google.com/c/NDA1MTY3MTI3NzQy/a/NDY0MjAwOTIyMjA2/details
ECE	https://classroom.google.com/c/NDA1MTY3MTI3NzQy/a/NDY0MjAwOTIyMjA2/details
EE	https://classroom.google.com/c/NDA1MTY3MTI3NzQy/a/NDY0MjAwOTIyMjA2/details