*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/M.TECH (EE-CI)/SEM-3/CIM-301B/2012-13**

**2012**

# OPTOELECTRONIC BASED 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.*

Answer Question No. **1** from **Group-A** and

any *two* from each of **Group-B** and **Group-C**.

## GROUP – A

1. Justify the correctness of the statements with reasons :

$7 \times 2$

a) A polarized light source cannot be used for creation of optical interference.

b) Intensity modulated optical fibre sensors are always extrinsic type.

c) Immunity to EMI makes an optical fibre unsuitable for sensing of magnetic field.

d) A quarter wave plate has a thickness equal to one fourth of the wavelength of the light source.

e) A piezoelectric crystal is used in an interferometer to vibration.

f) Holography is a form of two stage optical image recording.

g) For noise filtering ratiometric technique cannot be applied to intensity modulated fibre optic sensor circuits though it enhances accuracy of a colour modulated sensor.

## GROUP – B

2. a) What is $V$ number of an optical fibre ? How does it signify the number of modes in an optical fibre ?

A graded index fibre with a parabolic index profile supports the propagation of 742 guided modes. The fibre has a numerical aperture in air of 0·3 and a core diameter of 70 μm. Determine the wavelength of the light propagating in the fibre. Further estimate the maximum diameter of the fibre which gives single mode operation at the same wavelength. 7

b) What are different methods of intensity modulation techniques in fibre optic sensors ? Discuss with suitable examples.

A step index fibre has a core of index $n_1 = 1{\cdot}55$ and a cladding of index $n_2 = 1{\cdot}53$. If $RI$ temperature coefficient is $9{\cdot}8 \times 10^{-6}/°C$ at 656 nm and the ambient temperature varies by 25°C, what will be the percentage variation in incident light at the sensor output ? Will the linear thermal expansion of the optical fibre due to change in temperature have any effect on the magnitude of the incident light ? Discuss. 7

3. a) Discuss the following types of optical components — their types, functions and applications :

i) Beam splitters and diffraction gratings

ii) Polarizers. 7

b) Discuss the principles of operation of colour modulated fibre optic sensors. Develop schematically the following optical fibre based sensors and discuss their features along with principles of operation.

i) Radiation pyrometer

ii) Thermometer for sensing temperature of human body ( clinical thermometer )

iii) Temperature sensors for electrical machines — rotating and static ( transformer ). 7

4. a) Discuss with necessary sketches and mathematical expressions how an optical holography functions. 7

b) What are different techniques of modulation in frequency modulated optical fibre sensors ? Explain the phenomenon of Doppler shift and show how the principle can be used to measure the velocity of a moving object. To measure liquid flow rate of 0·5 m/s an optical source of frequency $10^{13}$ Hz was used. What Doppler shift was observed ? 7

5. Discuss the following : $4 \times 3\frac{1}{2}$

a) Fibre optic based distributed temperature sensor — principle, schematic diagram and applications.

b) Polarization modulated optical fibre based high voltage current sensors — principle, schematic diagram and applications.

c) Evanescent field modulated fibre optic immunoassay sensor — principle, schematic diagram and applications.

d) Phase modulated fibre optic temperature sensor — principle, schematic diagram and applications.

## GROUP – C

6. a) What are the different optoelectronic devices ? Explain the merits of optoelectronic systems. 2 + 2

   b) Explain the particle and wave nature of light. 2 + 2

   c) Explain the following terms and their unit in optics : 2 + 2 + 2

      i) Relative power

      ii) Absolute power

      iii) Optical energy.

7. a) Describe the mechanism of emission of light and classify them. 3

   b) Explain the principles of light emission in thermal and luminescent sources. 6

   c) Explain the optical parameters, merits and applications of LEDs. 5

8. a) Explain the following characteristics of photodetectors. 4 × 2

      i) Optical power ii) Quantum efficiency

      iii) Threshold energy iv) Cut-off wavelength.

   b) How does a photomultiplier tube function ? Estimate its merits and demerits. 6

9. Attempt any *four* short notes with example from the following : $4 \times 3\frac{1}{2}$

   a) Reflection b) Refraction

   c) Absorption d) Dispersion

   e) Scattering f) Coherence

   g) Polarization.