TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

Department of Electrical and Electronic Engineering

UNIVERSITY EXAMINATION FOR:

Diploma in Instrumentation and Control Engineering

ECI 2307: OPTICAL INSTRUMENTATION

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2019

TIME: 2 HOURS

DATE: AUGUST 2019

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Attempt any THREE Questions.

Do not write on the question paper.

Question ONE

a) With the aid of a diagram distinguish between the following types of optical measurement systems
   i) Vertical-Cavity Surface-Emitting Laser Technology
   ii) Edge emitting lasers

(8 marks)

b) Outline any FOUR advantages of VCSELs over Edge Emitters

(8 marks)

c) State any four advantages of optical instrumentation systems over equivalent electrical systems

(4 marks)

Question TWO

a) Determine the change in forward bias for doubling the forward current of a germanium semiconductor at 290^{o} K

(7 marks)

b) With the aid of diagrams explain the principle of operation of a Solar cell

(13 marks)

Question THREE

a) Distinguish between the following
   i) Constructive interference
   ii) Destructive interference

(4 marks)

b)
   i) With the aid of diagram describe the operation of Mach-Zehnder interferometer
   ii) State any **two** applications of the Mach-Zehnder interferometer
   iii) State any two applications of extrinsic fibre sensors

(10 marks)

c) Determine the optical path difference at which the fringes would disappear in a Michelson (Twyman–Green) interferometer using the following light sources:

(i) a white-light source and an interference filter (peak transmission at λ =550 nm, transmission bandwidth λ = 11.5 nm), and

(ii) a low-pressure mercury vapor lamp (λ = 546 nm, bandwidth $\lambda = 5 \times 10^{-3}$ nm)

(6 marks)

Question FOUR

a) State the Three Unique Characteristics / properties of laser light

(3marks)

b) (i) With the aid of a diagram explain the principle of operation of Fabry Pirot laser diode.
   (ii) State any **two** advantages of semiconductor lasers

(13 marks)

c) The beam of a 1 mW He – Ne Laser (633nm, W_o = 1.0 mm) is brought to a focus on the retina of human eye (focal length 35 mm). Determine:
   (i) The diameter of the focal point
   (ii) The power density in the focused spot

(4 marks)

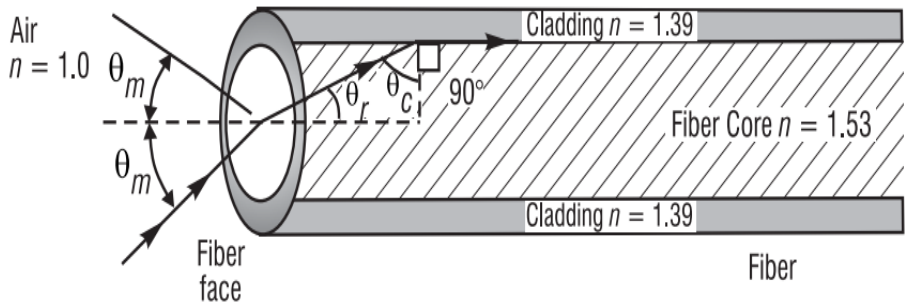
Question FIVE

a) Define the following terms as applied to optic fiber
   i) Cone of acceptance
   ii) Numerical aperture
   iii) Critical angle

(6 marks)

b) Given the step index fiber 0.0025 inch diameter has a core index of 1.53 and a cladding index of 1.39. Determine the maximum acceptance angle θ_m for a cone of light rays incident on the fiber face such that the refracted ray in the core of the fiber is incident on the cladding at the critical angle in Figure Q5c

(7 marks)



FigureQ5c

c) With the aid of a diagram explain the principle of operation of Laser Doppler velocimetry

(5 marks