



**TECHNICAL UNIVERSITY OF MOMBASA**

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**FACULTY OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF MEDICAL ENGINEERING**

**UNIVERSITY EXAMINATION FOR:**

**DIPLOMA IN MEDICAL ENGINEERING**

**EHL2303: OPTO-ELECTRONICS**

**SPECIAL/SUPPLEMENTARY EXAMINATION**

**SERIES:AUGUST2019**

**TIME:2HOURS**

**DATE:12Aug2019**

**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 question ONE (Compulsory) and any other TWO questions.

**Do not write on the question paper.**

Question ONE

- a) Explain
  - (i) Active mode locking
  - (ii) Passive mode locking (2 marks)
- b) Light moving from an optical fiber to air changes wavelength from 452nm to 633nm. (Take speed of light in vacuum  $c \approx 3.0 \times 10^8$  m/s)

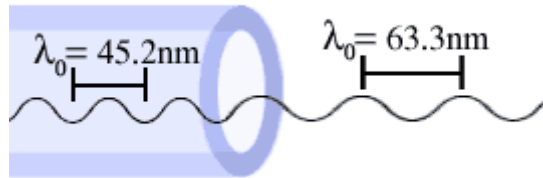


Figure Q1

- i). What is the index of refraction of the fiber?
- ii). What is the speed of light in the fiber?
- iii). What is the frequency of the light in the fiber?
- iv). What is the frequency of the light in air? (8 marks)
- c) With the aid of suitable illustrations explain three level and four level laser systems. (12 marks)
- d) Give reasons why:
  - i). four levels LASER is more efficient than three level LASER
  - ii). two level pumping schemes has no practical significance for lasing. (8 marks)

Question TWO

- a) Define the following terms as used in opto-electronics
  - i). Spontaneous emission
  - ii). Stimulated emission (4 marks)
- b) With the aid of a suitable diagram explain the working principle of a photo diode (9 marks)
- c) From the reverse current-Illumination curve for a photo-diode shown in Fig.Q2, determine the dark resistance. Assume a reverse-biased voltage of 10 V. (4 marks)

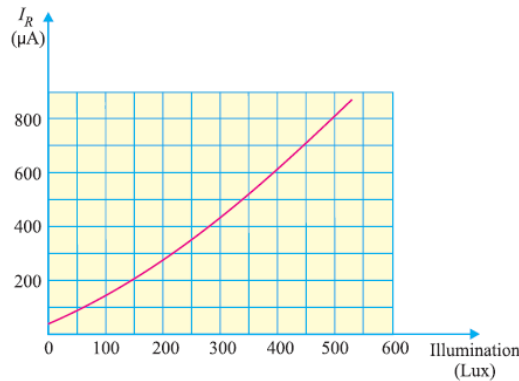


Figure Q2

- d) A photo-diode is exposed to light with an illumination of  $2.5 \text{ mW/cm}^2$ . If the sensitivity of the photo-diode for the given conditions is  $37.4 \text{ } \mu\text{A/mW/cm}^2$ , find the reverse current through the device. (3 marks)

### Question THREE

- a) What is the advantage of using lasers at the place of flash lamp in optical pumping? (2 marks)
- b) Light of vacuum wavelength  $\lambda_0 = 850.0 \text{ nm}$  enters the end of an optical fiber from air at an angle of  $20.5^\circ$  with respect to the normal. Its wavelength inside the fiber is  $574.3 \text{ nm}$ .
- What is the index of refraction inside the fiber?
  - What is the angle between the light ray and the normal inside the fiber?
  - Assuming the end of the fiber is perpendicular to its upper edge, what is the angle between the light ray and the surface when the light reaches the upper edge?
  - If the index of refraction outside the upper edge of the fiber is  $1.44$ , what is the angle between the light and the normal to the surface as it exits the upper edge?
  - For what range of angles in the core at the entrance of the fiber will the light be completely internally reflected at the core-cladding interface? (18 marks)

### Question FOUR

- a) With aid of well labelled diagram describe the construction and working principles of a laser diode. (9 marks)
- b) Enumerate the THREE unique characteristics of laser light. (3 marks)
- c) Draw a diagram of a typical optical fiber data link and explain the function of each element (8 marks)

### Question FIVE

- a) With the aid of suitable diagrams explain the following basic types of optical fiber:
- Multimode Step Index
  - Multimode Graded Index
  - Singlemode (12 marks)
- b) How are multicolored LED fabricated? (4 marks)
- c) State four advantages of LED. (4 marks)