The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

045

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX6253: Physical and Opto Electronics**
Academic Year	: 2021/2022
Date	: 16th Thursday, February 2023
Time	: 1330 - 1630 hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This is a Closed Book Test (CBT).
3. This question paper consists of **Six (06)** questions in **Three (03)** pages.
4. Answer **five (05) questions**.
5. All questions carry equal marks.
6. Answer for each question should commence from a new page.
7. Answers should be in clear handwriting.
8. Do not use Red color pen.
9. Assume any missing parameters with suitable values.
10. Clearly mention any assumption you make.

Note:

Charge of an electron = 1.602×10^{-19} C

Boltzmann constant = 1.381×10^{-23} JK^{-1} = 8.617×10^{-5} eVK^{-1}

Planck's constant = 6.626×10^{-34} Js

Speed of light in a vacuum = 3×10^{8} $m\,s^{-1}$

Section A

Q1.

(a) Distinguish between extrinsic and intrinsic semiconductor. [4 Marks]

(b) Define a hole. Clearly explain its importance in the conduction of semiconductor material. [6 Marks]

(c) To a sample of intrinsic silicon, we add 10^{17} atoms per cubic centimeter of phosphorus and 9×10^{16} atoms per cubic centimeter of carbon. Calculate the density of the majority and of the minority carriers at [10 Marks]

(i) $T = 300\ K$ (ii) $T = 600\ K$

Q2.

(a) Distinguish between conduction band and valance band. What is the significance of energy gap between them? [5 Marks]

(b) As the temperature of a sample of semiconductor that is doped with donor impurities is increased in which direction does E_F move? Explain. [5 Marks]

(c) For a particular semiconductor material $N_C = 1.5 \times 10^{18}\ cm^{-3}$, $N_V = 1.3 \times 10^{19}\ cm^{-3}$, and $E_G = 1.43\ eV$ at $T = 300\ K$. [10 Marks]

(i) Determine the position of the intrinsic Fermi level with respect to the centre of the bandgap.

(ii) What is the position of the Fermi level with respect to the top of the valance band E_V?

Q3.

(a) Explain the movement of energy bands when a diode is forward biased. [5 Marks]

(b) How does an increase of diode reverse bias increase the diode reverse current? [5 Marks]

(c) Draw and explain the energy band diagram of a p-n-p transistor. [5 Marks]

(d) Why is the gate-to-source connection open circuited in the small -signal equivalent circuit? [5 Marks]

Section B

Q4.

(a) Using simple ray theory, describe the mechanism for the transmission of light within an optical fiber. [5 Marks]

(b) Briefly discuss with the aid of a suitable diagram, what is meant by the acceptance angle for an optical fiber. Show how this is related to the fiber numerical aperture and the refractive indices for the fiber core and cladding. [6 Marks]

(c) An optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.25 and a cladding refractive index of 1.22. Determine

(i) the critical angle at the core cladding interface

(ii) the numerical aperture for the fiber

(iii) the acceptance angle in air for the fiber

[9 Marks]

Q5.

(a) Explain aid of a suitable diagram, discuss the principles of operation of LED. [5 Marks]

(b) Differentiate spontaneous emission and stimulated emission. [5 Marks]

(c) What is an injection laser? Explain its characteristics. [5 Marks]

(d) What are the advantages of using Laser in optical communication over LED. [5 Marks]

Q6.

(a) Compare the single mode and multimode fibers. [4 Marks]

(a) Explain the operation principal of a multimode graded index fiber. [5 Marks]

(b) What is a phototransistor? Explain in detail. [5 Marks]

(c) Describing the photovoltaic effect, explain the operation of the solar cell. [6 Marks]

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