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

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| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| Course Code and Title | : **EEX6253/EEX5543 Physical and Opto Electronics** |
| Academic Year | : 2020/2021 |
| Date | : 11th Friday, February 2022 |
| Time | : 0930 - 1230 hrs |

## 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

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## Note:

Charge of an electron = $1.602 \times 10^{-19}$ C

Boltzmann constant = $1.381 \times 10^{-23}$ $JK^{-1}$ = $8.617 \times 10^{-5}$ $eVK^{-1}$

Planck's constant = $6.626 \times 10^{-34}$ Js

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

## Section A

Q1.

(a) Why is the ability to conduct electricity or conductivity, higher in metals than in semiconductors at room temperature? [5 Marks]

(b) If the temperature of an intrinsic semiconductor is increased what would happen to its conductivity? Explain. [5 Marks]

(c) As the temperature of a sample of semiconductor that is doped with donor impurities is increased, in which direction does the $E_F$ move? Justify your answer. [5 Marks]

(d) Why and how does the mobility depend on doping? Explain

[5 Marks]

Q2.

(a) Briefly explain the difference between the $i - v$ relationships of a silicone and a gallium arsenide diode. [6 Marks]

(b) Explain the movement of the energy bands when a diode is forward-biased.

[6 Marks]

(c) Calculate the built-in potential barrier in a silicon $p - n$ junction at $T = 300\,K$ with doping densities $N_a = 1 \times 10^{18}\,cm^{-3}$ and $N_d = 1 \times 10^{16}\,cm^{-3}$. Assume that $n_i = 1.5 \times 10^{10}\,cm^{-3}$. [8 Marks]

Q3.

(a) To switch a transistor (PNP) from cut-off to saturation, what should happen to the hole density in the base and how is this accomplished? [6 Marks]

(b) Explain the difference between the pinch-off voltage and the threshold voltage. [7 Marks]

(c) Explain how there is a drain current after the channel is pinched off.

[7 Marks]

## Section B

Q4.

(a) Briefly outline the main components in an optical fiber communication system. [5 Marks]

(b) Briefly explain the following with suitable diagrams:

(i) Acceptance angle

(ii) Numerical aperture (NA)

(iii) Total internal reflection [6 Marks]

(c) A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine

(i) The critical angle at the core-cladding interface

(ii) The NA for the fiber

(iii) The acceptance angle in air for the fiber

[9 Marks]

Q5.

(a) Explain the main difference in the operating principles of LASER and LED. [5 Marks]

(b) Differentiate Spontaneous emission and Stimulated emission. [5 Marks]

(c) Discuss on the noise in LASERs. [5 Marks]

(d) Explain the role of LASERs in Optical communication networks. [5 Marks]

Q6.

(a) Differentiate the operations of $p-n$ diode and $p-i-n$ diodes with the aid of suitable diagrams. [6 Marks]

(b) Justify the statement "Intermodal dispersion in multimode fibers is minimized with the use of graded index fibers." [7 Marks]

(c) Describing the photovoltaic effect, explain the operation of the solar cell. [7 Marks]

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