051

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

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX6253: Physical and Opto Electronics**
Academic Year	: 2023/2024
Date	: 15th Friday, February 2025
Time	: 0930 - 1230 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 **Five (05)** questions in **Three (03)** pages.
4. Answer **all 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} $m\,s^{-1}$

Q1.

(a) Define the following terms

i. Valance electron

ii. Forbidden energy gap

iii. Drift current

[3×02 Marks]

(b) Explain the term "Mobility" with respect to semiconductors and how does mobility depend on doping?

[04 Marks]

(c) A silicon bar with a cross-sectional area of $0.5\,mm^2$ and a length of $1\,cm$ is subjected to an electric field of $100\,V/m$. The silicon has an electron concentration of $1.5 \times 10^{16}\,cm^{-3}$ and a hole concentration of $1 \times 10^{15}\,cm^{-3}$. The electron mobility (μ_n) is $1350\,cm^2/V \cdot s$, and the hole mobility (μ_p) is $480\,cm^2/V \cdot s$. Calculate the total drift current flowing through the semiconductor.

[10 Marks]

Q2.

(a)

i. What happens when a diode is subjected to a high reverse voltage? Explain.

ii. Differentiate between Zener Breakdown and Avalanche Breakdown.

[2×04 Marks]

(b) What happens at the junction when the p −type and n −type materials come into contact?

[05 Marks]

(c) A silicon pn junction with doping concentrations $N_a = 2 \times 10^{17}\text{cm}^{-3}$ and $N_d = 3 \times 10^{15}\text{cm}^{-3}$ at T=320 K. Calculate the built-in voltage V_0.

[07 Marks]

Q3.

(a) Explain the difference between depletion-mode and enhancement-mode MOSFETs based on doping and channel formation. [10 Marks]

(b) Explain how increasing the reverse bias at the gate affects the channel in JFET. [10 Marks]

Q4.

(a)

i. What are the primary sources of signal loss in optical fibers?

ii. How does material absorption, scattering, and bending loss contribute to attenuation? [2 × 04 Marks]

(b) A digital communication system uses an optical fiber with the following parameters: Core refractive index $(n_1) = 1.48$, Cladding refractive index $(n_2) = 1.45$, Wavelength of transmitted light $= 1550\,nm$, Fiber length $= 10\,km$, Attenuation coefficient $= 0.2\,dB/km$, Input optical power $(P_{in}) = 5\,mW$. Calculate the following:

a. the Numerical Aperture (NA) of the fiber

b. the Acceptance Angle of the fiber in air

c. the total optical power received at the other end of the fiber

d. the total signal loss (in dB) over the fiber length

[4 × 03 Marks]

Q5.

(a) Explain the working principles and operation of following optical devices with suitable diagrams.

i. Light Emitting Diode (LED)

ii. Photodiode

iii. Laser Diode

[3 × 04 Marks]

(b) Describe how solar cells utilize the photovoltaic effect to convert sunlight into electrical energy. [08 Marks]

-end-