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	: 2024/2025
Date	: 07th Saturday, February 2026
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) Explain the conduction in materials using the band theory.

[05 Marks]

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

[05 Marks]

(c) At $T = 300$ K, silicon is doped with donor concentration $N_D = 10^{16}$ cm^{-3}. $n_i = 1.5 \times 10^{10}$ cm^{-3}.

(i) Find the electron concentration.

(ii) Determine the position of the Fermi level relative to the conduction band edge E_c.

[10 Marks]

Q2.

(a) A silicon diode operates under reverse bias.

(i) Explain the conditions under which Zener breakdown occurs.

(ii) Explain avalanche breakdown and differentiate it from Zener breakdown.

[2×05 Marks]

(b) A silicon $p-n$ junction is formed by doping with $N_a = 1 \times 10^{18}$ cm^{-3} and $N_d = 2 \times 10^{16}$ cm^{-3} at $T = 350\ K$. Determine the built-in voltage of the junction. Assume intrinsic carrier concentration $n_i = 2.5 \times 10^{10}$cm^{-3}.

[10 Marks]

Q3.

(a) Explain the significance of threshold voltage in MOSFET operation and discuss the main factors affecting it.

[10 Marks]

(b) Explain how increasing the gate-to-source voltage affects the drain current in a JFET.

[10 Marks]

Q4.

(a) What are the sources of dispersion in optical fibers? Explain how intermodal dispersion limits the bandwidth of an optical fiber.

[8 Marks]

(b) A long-haul digital communication system employs a single-mode step-index optical fiber operating at a wavelength of $1550\,nm$. The fiber has a relative refractive index difference of $\Delta = 0.36\%$ and a core refractive index $n_1 = 1.468$. The fiber link length is $25\,km$ and the attenuation of the fiber is $0.25\,dB/km$. The optical transmitter launches an average power of $10\,mW$ into the fiber. Calculate the following:

i. The cladding refractive index of the fiber

ii. The Numerical Aperture (NA) of the fiber

iii. The acceptance angle of the fiber in air

iv. The total attenuation of the optical signal over the fiber length

[4 × 03 Marks]

Q5.

(a) Describe the principle of operation and characteristics of the following optoelectronic devices with suitable diagrams:

(a) Photodiode

(b) Solar cell

[2 × 04 Marks]

(b) Describe the principle of operation of a PIN photodiode and explain how it improves the performance of optical receivers.

[06 Marks]

(c) Describe how optical detectors convert optical signals into electrical signals in fiber-optic communication systems.

[06 Marks]

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