(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2023/2024 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATION ENGINEERING

COURSE CODE: ECE 251

COURSE TITLE: PHYSICAL ELECTRONICS

DATE: TUESDAY 19/12/2023 **TIME:** 12:00 PM – 2:00 PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

CONSTANTS

$k = 1.38 \times 10^{-23} J/K^0$ - Boltzmann's Constant

$h = 6.67 \times 10^{-34} J \times K^0$ - Planck's Constant

$\varepsilon_0 = 8.57\prod \times 10^{-12} F/m$ - Permittivity

$m = 4\prod \times 10^{-7}$ H/m - Permeability

$m_0 = 9.1 \times 10^{-31} Kg$ - Mass at Rest

QUESTION ONE

1. Explain and indicate the position of Femi Level in an intrinsic semiconductor ***(7marks)***
2. An electron at rest is accelerating through a potential deifference of 100V. Calculate its final kinetic energy in:
   i. Joules
   ii) Electron Volts ***4 x 2 = (8marks)***
3. Define and express the following terms;
   i. Mobility
   ii. Conductivity
   iii. Electron Volt
   iv. Peak Inverse Voltage
4. Distinguish between *Zener breakdown* and *Avalanche Breakdown.*
5. The current flowing through a ***p-n junction*** of ***Si diode*** in ***60 mA*** for a forward bias of ***0.9v at 300^0K.*** Determine the static and dynamic resistance of the diode. ***(6marks)***

QUESTION TWO

1. a) Using suitable and illustrations explain how an *n-type* semi conductor may be formed ***(8 marks)***
   b) Find:
   i) The conductivity: *and*
   ii) The resistance of a bar of pure silicon of length 1cm and cross- sectional area $1mm^2$ at 300^0K

   For the requirements *i) and ii)* the following have been given:

   $\mu_n = 0.13 m^2/v.s$; $\mu_p = 0.05 m^2/v.s$
   $n_i = 1.5 \times 10^{16} m^{-3}$ and $e = 1.6 \times 10^{-19}$ ***(12marks)***

QUESTION THREE

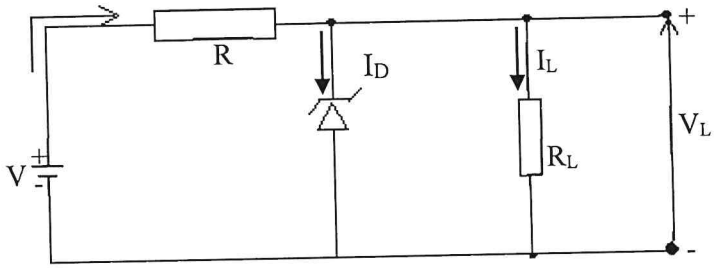

Figure 1

a) In the ***figure 1*** V= 35V, $I_Z = 25mA$, $I_L = 5mA$. If the K'nee voltage of Zener diode is $V_{ZO} = 7V$ and its resistance$\sqrt{Z} = 6\ \Omega$. Calculate the value of the resistance R. **(8marks)**

b) State and outline basic factors determining rectifier performance. ***(6 marks)***

c) Derive that the ripple factor of half wave rectifier. ***(6marks)***

QUESTION FOUR

a) State Five postulates of an atomic model **(5 marks)**

b) Derive the hole carrier density of an extrinsic material

$$P = \frac{Nd}{2} + \frac{N_d}{2}\left[1 + \left(\frac{2ni}{N_d}\right)^2\right]^{\frac{1}{2}}$$ (8 marks)

c) A rectangular semiconductor specimen *2mm* wide and *1mm* thick gives a Hall coefficient of $10^{-2}m^3/c$. When a current of 1mA is passed through the sample, a Hall voltage of 1mV is developed. Find;

i) The magnetic field ***(4marks)***

ii) The Hall coefficient ***(3marks)***

QUESTION FIVE

a) A Silicon *p-n junction* diode operates at 27^0C. If the applied forward bias is increased, the current I is doubled. Determine the increase in the bias voltage (Assume I >> I_S) ***(8mks)***

b) Briefly describe the principle operations of the following devices

i) Varactor Diode ***(4marks)***

ii) Solar Cell ***(4marks)***

iii) Switching Diode ***(4marks)***