CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

PHYS 271: BASIC ELECTRONICS

STREAMS: **TIME: 2 HOURS**

DAY/DATE: THURSDAY 08/07/2021 **2.30 P.M -4.30 P.M**

INSTRUCTIONS:

Answer question ONE and any other TWO questions

Do not write on the question paper

Physical constants

Planks constant $h = 6.62607 \times 10^{-34}\, JS$

Reduced planks constant $\hbar = 1.05457 \times 10^{-34}\, JS$

Boltzmann constant $K = 1.38066 \times 10^{-23}\, J/K$

Electron-Volt (ev) $= 1.60218 \times 10^{-19}\, J$

Elementary charge (q) $= 1.60218 \times 10^{-19}\, C$

QUESTION ONE (30 MARKS)

a. Distinguish between intrinsic and extrinsic semiconductors (2marks)
b. Using energy band diagrams, distinguish metals, insulators and semiconductors (3marks)
c. Using appropriate band diagrams differentiate between P-type and N-type semiconductors (4marks)
d. (i)A Si sample is doped with 10^{17}Arsenic atoms/cm^3. Determine the equilibrium hole (P) concentration at 300K, given that the intrinsic carrier concentration of Si is (4marks)

   $n_i = 9.65 \times 10^{9}\, cm^{-3}$

   (ii)Using appropriate band diagram show where the Fermi level (E_F) is relative to E_i.

   (4marks)

e. i) Define the term noise in a semiconductor device (2marks)
ii) Define the term noise power spectral density (2marks)

f. The mobility of free electrons and holes in pure germanium are 3800 and 1800 $cm^2/V.S$ respectively. The corresponding values for pure silicon are 1300 and 500 $cm^2/V.S$ respectively. Determine the values of intrinsic conductivity for both germanium and silicon. Assume $n_i = 2.5\times10^{13} cm^{-3}$ for germanium and $n_i = 1.5\times10^{10} cm^{-3}$ for silicon at room temperature.

(5marks)

g. Differentiate between forward bias and reverse bias of a P-N junction

(4marks)

QUESTION TWO (20 MARKS)

a) Explain the main difference between a Bipolar Junction Transistor (BJT) and a Field Effect Transistor (FET) (4marks)

b) A BJT has $\alpha = h_{FB} = 0.99$. Determine h_{FE} (3marks)

c) When a reverse gate voltage is applied to a JFET, The gate current is 1nA. Determine the resistance between gate and source (5marks)

d) A FET has a driven current of 4mA. If the I_{DSS} = 8mA and V_{GS}(off)=-6V. Find the values of V_{GS} and V_P. (8marks)

QUESTION 3 (20 MARKS)

a) Briefly describe how a P-N junction is made. (6 marks)

b) Given that germanium at room temperature $n_i = 2.5 \times 10^{13}/cm^3$, μ_n = 3800 cm^2/V-Vs, μ_p = 1800 cm^2/V-Vs and a number of Germanium atoms/$cm^3 = 4.4 \times 10^{22}$.
Determine the resistivity of germanium:

i. in intrinsic condition at 300 K (4 marks)
ii. with donor impurity of 1 in10^7 (6 marks)
iii. with acceptor impurity of 1 in 10^8 (4 marks)

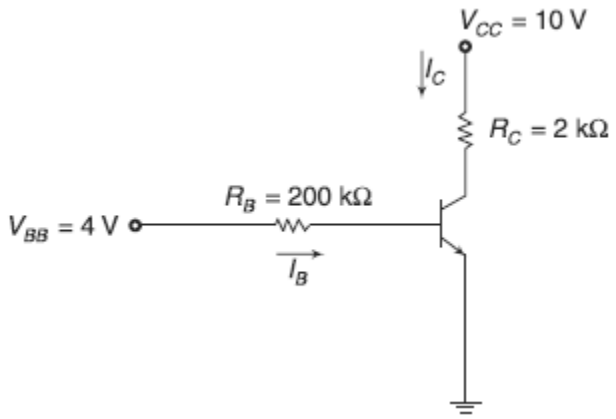
QUESTION FOUR (20 MARKS)

a) What is a Bipolar junction transistor (2marks)

b) Briefly describe the operation of N-P-N transistor (4marks)

c) Differentiate between avalanche breakdown and Zener breakdown (4 marks)

d) Determine the base, collector and emitter currents and VCE for a CE circuit shown in the figure, For
V_{CC} = 10 V, V_{BB} = 4 V, R_B = 200 kΩ, R_C = 2 kΩ, V_{BE} (on) = 0.7 V, and β = 200. (10 marks)



QUESTION FIVE (20 MARKS)

a) Briefly discuss four methods of classifying amplifiers (8 marks)

b) With the aid of a well labelled diagram, discuss how a transistor can be used as an amplifier. (12marks)
