CHUKA  **UNIVERSITY**

SUPPLEMENTARY/ SPECIAL EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF
BACHELOR OF SCIENCE IN EDUCATION, BACHELOR OF SCIENCE

PHYS 271: BASIC ELECTRONICS

STREAMS: BSC **TIME: 2 HOURS**

DAY/DATE: MONDAY 01/02/2021 **8.30 AM – 10.30 AM**

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 1

a. Distinguish between intrinsic and extrinsic semiconductors (2mks)

b. Using energy band diagrams, distinguish metals, insulators and semiconductors (3mks)

c. Using appropriate band diagrams differentiate between P-type and N-type semiconductors (4mks)

d. 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 (4mks)
$n_i = 9.65 \times 10^{9}\, cm^{-3}$

e. Using appropriate band diagram show where the Fermi level (E_F) is relative to E_i. (4mks)

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

g. 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. (5mks)

h. Differentiate between forward bias and reverse bias of a P-N junction. (4mks)

Question 2

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

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

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

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

Question 3

a) Briefly describe how a P-N junction is made. (5mks)

b) Consider an abrupt P-N diode which consists of a P-type region containing 10^{16} cm^{-3} acceptors and an N-type region containing also $10^{16} cm^{-3}$ acceptors in addition to $10^{17} cm^{-3}$ donors.

i) Calculate the thermal equilibrium density of electrons and holes in the P-type region as well as both densities in the N-type region given $n_i = 10^{10} cm^{-3}$ (5mks)

ii) Calculate the built in potential of the P-N diode (5mks)

iii) Calculate the built in potential of the diode at 100 ^oC (5mks)

Question 4

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

b) Briefly describe the operation of N-P-N transistor (6mks)

c) Consider a BJT with emitter doping of $10^{18}cm^{-3}$ and base doping of $10^{17}cm^{-3}$. The quasi – neutral region width in the emitter is 1µm and 0.2 µm in the base.
Take μ_n =1000cm^2/V.S and μ_p =300cm^2/V.S
The minority carrier life time in the base is 10nS. The BJT when it is biased in the forward active mode.
Calculate the following parameters of the BJT

i) the emitter efficiency (6mks)
ii) The base transport factor (6mks)

Question 5

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

b) With the aid of a well labelPled diagram, discuss hoe a transistor can be used as an amplifier. (12mks)
