(*Knowledge for Development*)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

END OF SEMESTER EXAMINATIONS
YEAR THREE SEMESTER ONE EXAMINATIONS

FOR THE DEGREE OF
BACHELOR OF SCIENCE COMPUTER SCIENCE

COURSE CODE : CSC 352E

COURSE TITLE : SEMICONDUCTOR DEVICES

DATE: 18/01/2018 TIME: 09:00 A.M - 11:00 A.M

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTIONS ONE AND ANY OTHER TWO.

Constants;

$e = 1.602 \times 10^{-19} C$

$m_e = 9.1 \times 10^{-31} kg$

QUESTION ONE

a) Define the following terms

i) Conductors [1 mark]

ii) Insulators [1 mark]

iii) Semi-conductors [1 mark]

b) State any three assumptions made in the Bohr's Atomic Theory [3 marks]

c) Explain the forward and reverse bias conditions in bipolar junction transistors [6 marks]

d) Briefly describe three ways in which holes and free electrons are produced in semiconductors [3 marks]

e) In a certain copper conductor, the current density is 2.4 A/mm^2 and electron density is 5 x 10^{28} free electrons per m^3 of copper. Determine the drift velocity of the electrons [2 marks]

f) Outline the steps in Integrated circuit (IC) fabrication [4 marks]

g) Describe the formation of potential barrier in a *pn* junction. [3 marks]

h) Explain the term wafer fabrication [2 marks]

i) A specimen of germanium at 300k for which the density of carriers is 2.5 x 10^{13} per cm3, is doped with impurity atoms such that there is one impurity atom for 10^6 germanium atoms. All the impurity atoms may be assumed ionized. The resistivity of doped material is 0.039Ω-cm. carrier mobility for germanium at 300 k is 3,600 cm^2/V-s. for the doped material, determine the electron and hole densities [4 marks]

QUESTION TWO

a) State two applications of hall effect [2 marks]

b) Draw a well labeled common emitter NPN transistor test circuit for the various transistor characteristics [4 marks]

c) Sketch and explain the following characteristics for the test circuit of 2 b) above

i) Input characteristic [3 marks]

ii) Output characteristic [3 marks]

i) List **Two** advantages of Junction Field Effect Transistors (JFETs) over Bipolar Junction Transistors(BJTs) [2 marks]

d) Using relevant examples, explain the following chemical bonds

i) Ionic/Electrovalent bond [3 marks]

ii) Covalent bond [3 marks]

QUESTION THREE

a) What is Fermi level [2 mark]

b) Explain any three factors that affect resistance of semiconductor materials [6 marks]

c) A donor type impurity is added to the extend of one atom per 10^6 atoms of an intrinsic semiconductor (silicon). Determine;

i) Resulting donor atom concentration [2 marks]

ii) Resulting mobile electron concentration [3 marks]

iii) Resulting hole concentration [2 marks]

iv) Conductivity of doped silicon sample [2 marks]

d) If silicon bar is 0.5 cm long, cross-sectional area of $(5 \times 10^{-4})^2$ cm^2, find its resistivity. [3 marks]

(The concentration of silicon atoms = 5×10^{22} cm^{-3} and $n_i = 1.45 \times 10^{10}$ cm^{-3})

QUESTION FOUR

a) Define the following terms;

i) Drift current [2 marks]

ii) Diffusion current [2 marks]

b) A potential difference of 10 V is applied longitudinally to a rectangular specimen of intrinsic germanium of length 25mm, width 4mm and thickness 1.5 mm. determine at room temperature;

i) Electron and hole drift velocities [3 marks]

ii) The conductivity of intrinsic germanium if intrinsic carrier density is 2.5×10^{19} m^3 [2 marks]

iii) The total current [2 marks]

($\mu_e = 0.38\ m^2V^{-1}s^{-1}$. $\mu_h = 0.18\ m^2\ V^{-1}\ S^{-1}$)

c) Discuss the following transistor fabrication techniques

i) Diffused planar transistor [3 marks]

ii) Epitaxial mesa [3 marks]

iii) Diffused mesa [3 marks]

QUESTION FIVE

a) What is Hall Effect? [2 marks]

b) Briefly describe the following diode fabrication techniques

i) Grown junction diode [3 marks]

ii) Fused junction diode [3 marks]

iii) Point contact diode [3 marks]

c) Discuss the following applications of zener diode

i) Switching operation [3 marks]

ii) Meter protection [3 marks]

iii) Voltage regulation [3 marks]