THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL & ELECRONIC ENGINEERING

EEE 2204: PHYSICAL ELECTRONICS I

BACHELOR OF ENGINEERING IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE 4207: PHYSICAL ELECTRONICS I

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: OCTOBER 2011

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer booklet*

This paper consists of **FIVE** questions. Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are clearly shown.
This paper consists of **THREE** printed pages

SECTION A (COMPULSORY)

Question 1

a) (i) Describe the term Hall Effect
   (ii) Differentiate between drift and diffusion currents
   (iii) With the aid of a diagram, describe mobility as a function of temperature
   (iv) Explain the conduction mechanism in intrinsic semiconductor (11 marks)

b) (i) Define Fermi level
   (ii) A silicon sample is doped with a baron concentration of 016 and a phosphorous

concentration of 2 x 10^{15} cm^{-3} at room temperature
Determine the type of material and the election and hole concentrations (7 marks)

c) Consider a p-n-prototype homo-junction at equilibrium. Draw the following.

i. Physical diagram
ii. Distribution of charge as a function of position in the junction
iii. Electric field as a function of position in the junction
iv. Energy band diagram (7 marks)

d) (i) Define p-n junction (7 marks)
(ii) State TWO mechanism responsible for junction breakdown
(iii) State the TWO capacitance in a p-n-junction (5 marks)

SECTION B (Answer *any TWO questions from this section - 20 marks each*)

Question 2

a) (i) Define forbidden energy band.
(ii) State the law of mass action
(iii) Calculate the intrinsic concentration for Silicon at T = 300k (8 marks)

b) Consider Silicon at T = 300K. Calculate
i. The probability that a state in the conduction band is occupied by an electron
ii. Thermal equilibrium electron concentration (7 marks)

c) The density of free electron in pure Silicon at 300K is 1.5 x 10^{16} m^{-3} and its conductivity is 4.5 x 10^{-4} s/m. Given that the electron mobility in silicon is 0.14 m/v.s, calculate:
i. The hole mobility at 300K
ii. Hence find the conductance of extrinsic Silicon with uniform donor densities of 10^{20} atoms/m^3, 10^{23} atoms/m^3 and 10^{26} atoms/m^3 (3 marks)

Question 3

a) (i) Define compensated semiconductor
(ii) Explain how compensated semiconductor can be formed
(iii) Differentiate between degenerate and non-degenerate semiconductor (4 marks)

b) (i) Draw the Fermi probability function versus energy for different temperature.
(ii) Consider a semiconductor at T = 300K. Determine the probability that an energy level
μ
3 T above the Fermi energy level is occupied by an electron (11 marks)

c) (i) State the BOLTZMANN approximations
(ii) State when and why BOLTZMANN approximations can safely be used (5 marks)

Question 4

Consider the following type of p-n-junction diodes

- Zener diode
- Varactor diode
- Tunnel diode
- Schottky barrier diode

i. Draw schematic symbols and with aid of well labeled characteristic curve, briefly explain the operating principles for each diode type

ii. Highlight **ONE** area of application for each diode (20 marks)

Question 5

a) (i) Explain what is donor and acceptor impurity
(ii) What is the product of n_0 and p_0 equal to? (5 marks)

b) (i) State the technique of space neutrality (5 marks)
(ii) Using the technique above, derive an expression of determining the concentration of electrons in a non-degenerate semi-conductor at high temperature greater than 400K. Assume also that all impurities are ionized (10 marks)

c) Explain how an intrinsic semi-conductor can be made into N-type and P-type semiconductor (5 marks)