TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTHY SCIENCES

DEPARTMENT OF MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS (BTAP)

APS 4309: SEMICONDUCTOR PHYSICS AND DEVICES

SPECIAL/ SUPPLIMENTARY EXAMINATIONS

SERIES: September 2018

TIME: 2 HOURS

DATE: September 2018

INSTRUCTION TO CANDIDATES

You should have the following for this examination.
-Answer Booklet, examination pass and student ID.
This paper consists of FIVE questions.
Answer question ONE (COMPULSORY) and ANY other TWO questions.
The maximum marks for each question is shown.
Do not write on the question paper.
Mathematical tables and scientific calculators may be used.

Constants

Electron charge	$e = 1.602 \times 10^{-19}C$
Electron mass	$m = 9.11 \times 10^{-31}Kg$
1electron volt	$1.0\ eV = 1.602 \times 10^{-19}J$
Plank's constant	$h = 6.6 \times 10^{-34}Js$
Permittivity constant	$\varepsilon_o = 8.85 \times 10^{-12}N^{-1}m^{-2}C^2$

Question One (30 marks)

a) Explain the differences between conductor, semiconductor and insulator in terms of energy bands (3marks)
b) Define intrinsic and extrinsic semiconductor (2marks)
c) What is doping as applies to semiconductors? Give an example (3marks)
d) Explain the two major factors that determine the rate of conductivity of a semiconductor. Of these factors explain which one contributes more to conductivity (4marks)
e) Explain the difference between the following:
    i) Diode and transistor (3marks)
    ii) Forward and reverse biased diode (2marks)
f) State Pauli's' exclusion principle in atomic structure. Explain two importance of this principle in atomic structure (4marks)
g) By comparing angular momentum to postulated Bohr momentum, show that the velocity v of orbiting electron at quantum number n and radius r is given by $v = n\hbar/m_e r$ (7marks)
h) Given two materials; pure semiconductor and a metal, what difference will you identify when the two are subjected to same temperature? (2marks)

Question Two (20 marks)

a) Prove that the Bohr radius of hydrogen atom is a constant and show its numerical value (8marks)
b) Show that the total energy possessed by orbiting electron at n quantum state is given by

$$E_n \approx -\frac{m_e(Z-1)^2 e^4}{2(4\pi\varepsilon_0)^2\hbar^2}\frac{1}{n^2} \approx -\frac{(Z-1)^2 \times 13.6eV}{n^2}.$$

All symbols applied are standard. (8marks)
c) Suppose that in an atom of copper (Z=29) in the target of an X-ray tube, one of the electrons in the n=1 state is ejected during the impact of the electron beam on the target. Suppose that subsequently one of the other electrons in the atom jumps from the n=2 state into this available empty n=1 state. What is the energy and the wavelength of the photon emitted during this quantum jump? (4marks)

Question Three (20 marks)

a) Explain what a thermistor is and its use with an example (6marks)

b) Describe a photodiode in terms of its operation (6marks)

c) Figure 2 below is of a phototransistor operating relay

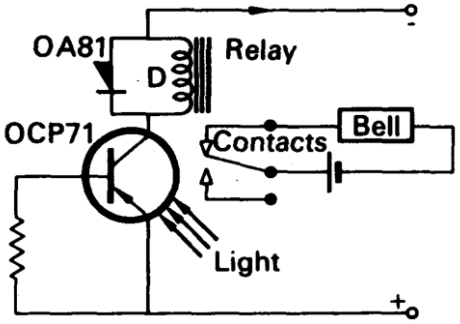

Figure2

i) Explain what a phototransistor is (4marks)

ii) Briefly describe how it operates in the above figure (4marks)

Question Four (20 marks)

a) With illustrations, describe Zener effect of a diode and explain why Zener diodes are commonly used as stabilizers in circuits (7marks)

b) Describe the two common types of transistors with their circuit symbols (6marks)

c) Figures 3 below were characteristics of common base transistor

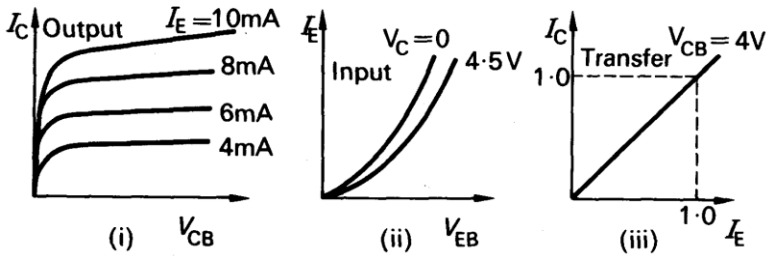

Figure 3

Explain these characteristics in relation to output and input resistance and current transfer (7marks)

Question Five (20 marks)

The figure 4 below is of a transistor in a basic C-E arrangement.

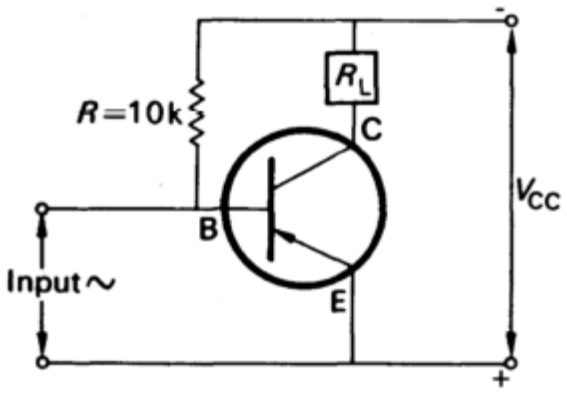

Figure 4

a) Which transistor type is displayed in figure 4? (1mark)
b) Briefly explain the role of R and R_L in the circuit (2marks)
c) Suppose the base current changes by ΔI_B, determine how much collector current changes in terms of base current change and hence the voltage gain if current gain is β (6marks)
d) Determine the voltage gain of the circuit with input resistance r_i of 1000Ω and load of 4700Ω if current gain is 49 (3marks)
e) With illustrations, precisely describe the output and transfer characterics of acommon emmiter in the circuit. (8marks)