

KABARAK



UNIVERSITY

EXAMINATIONS
2008/2009 ACADEMIC YEAR
FOR THE DEGREE OF BACHELOR OF EDUCATION
SCIENCE

COURSE CODE: PHYS 422

COURSE TITLE: SEMICONDUCTOR PHYSICS

STREAM: SESSION VII

DAY: FRIDAY

TIME: 2.00 – 4.00 P.M.

DATE: 14/08/2009

INSTRUCTIONS

- 1. Answer Question ONE and any other TWO questions.**
- 2. Question ONE carries 40 marks. Questions TWO – FOUR carry 15 marks each.**
- 3. Assume $\pi = 3.14$**

PLEASE TURN OVER

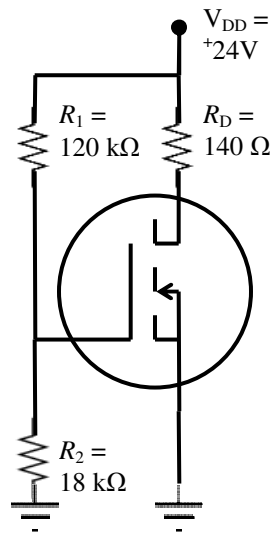
QUESTION ONE: (40 MARKS)

- a) What is the name of the bond that is created when atoms share valence electrons?
(1 mark)
- b) Briefly differentiate between semiconductors and conductors in terms of their atomic structure, band diagrams and temperature dependence.
(2 marks)
- c) Of the currents in a bipolar junction transistor, which one is the largest?
(2 marks)
- d) What is the main difference between half-wave rectifiers and full-wave rectifiers?
(2 marks)
- e) Explain how atoms in depletion regions of p-n junctions become ions during diffusion.
(4 marks)
- f) To achieve an output of 10V in a bipolar junction transistor whose input is 300mV, what amplification factor (voltage gain) is required?
(3 marks)
- g) In your own words, state whether you think electronic devices have affected everyday life positively or negatively. Describe how or why you think that way and if possible give examples.
(10 marks)
- h) If the ac mains power supply of a half-wave rectifier has a frequency of 60Hz, what will be the frequency of the rectifier's output signal?
(2 marks)
- i) Draw the voltage-current (V-I) characteristics of an ideal diode.
(4 marks)
- j) Define the Fermi energy of a semiconductor, write down the equation for calculating the probability of finding an electron at an energy level E_x and show the relative locations of the Fermi energy on both *p*-type and *n*-type semiconductors.
(6 marks)
- k) Define the following parameters as used in D-MOSFET operation.
- i) I_{DSS}
ii) $V_{GS(off)}$
(4 marks)

QUESTION TWO (15 MARKS)

- a) Draw the structure of a p-channel depletion mode MOSFET and label all parts. How does the circuit symbol of this type of transistor look like?
(8 marks)

- b) Calculate V_{GS} and V_{DS} for the E-MOSFET circuit below. Assume the circuit has a value of $K = 50\text{mA/V}^2$ and $V_{TH} = 2\text{V}$.



(7 marks)

QUESTION THREE: (15 MARKS)

- a) Explain how a centre tapped full-wave rectifier works. In your explanation show schematic diagrams of the circuit and the different waveforms at the two ends of the circuit. (9 marks)
- b) Draw the band diagram of a p-n junction when a forward bias of value V is applied to the junction. (6 marks)

QUESTION FOUR (15 MARKS)

- a) Describe in detail the behavior of carriers from the moment a p-n junction is formed, to the time the junction attains equilibrium. (12 marks)
- b) Define pinch-off voltage as used in Field Effect Transistors and state one way in which pinch-off could be induced early for a p-channel JFET. (3 marks)