

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: THURSDAY

TIME: 2.00 – 4.00 P.M.

DATE: 27/11/2008

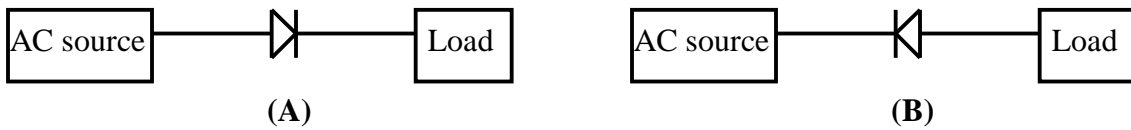
INSTRUCTIONS:

1. Answer **Question ONE** and **any other TWO** questions.
2. **Question ONE** carries **40 marks**, all other questions carry **15 marks** each.
3. Assume $\pi = 3.14$ and the barrier potential for silicon diodes is 0.7V

PLEASE TURN OVER

QUESTION ONE (40 MARKS) – COMPULSORY

- a) Draw a schematic illustration of the atomic structure of a neutral sodium atom (atomic number = 11) showing the location of all the particles in the atom. 8 marks
- b) What do you understand by the term *intrinsic semiconductors*? 3 marks
- c) Name the four main processes described by the continuity equation. 4 marks
- d) Define the term Fermi Level as used in semiconductor physics. 3 marks
- e) Does reverse-biasing a p-n junction increase or decrease the width of the depletion region at the junction? Briefly explain how that occurs. 6 marks
- f) The diagrams below show the block diagrams of a half-wave rectifier with the diode connected in opposite directions. From your knowledge of diode physics, draw the structure of the output signals generated by the rectifier in both cases.



- g) Define the following parameters as used in MOSFET operation. 6 marks
 - i) I_{DSS}
 - ii) $V_{GS (off)}$4 marks
- h) Name two of the parameters used to determine the efficiency of a Bipolar Junction Transistor and indicate the ideal values of each. 6 marks

QUESTION 2 (15 MARKS) – OPTIONAL

- a) Briefly explain the three main regions of operation of a MOSFET, i.e., cut-off, triode and saturation. 9 marks
- b) In the semiconductor doping process, use covalent bonding diagrams to explain how n-type semiconductor materials are created. 6 marks

QUESTION 3 (15 MARKS) – OPTIONAL

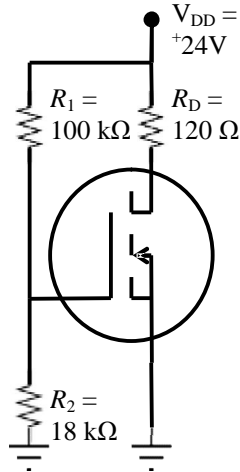
- a) Calculate the Ripple Factor for a Capacitor-Input Filter circuit if the frequency of the signal is 120 Hz, the peak output voltage is 12V and the resistor (R_L) and capacitor (C) have values of $3k\Omega$ and $40\mu F$ respectively. *Ripple factor* = $V_{avg} / V_{r(pp)}$. 10 marks

- b) With the aid of a diagram, show how you would connect a diode to get its I-V characteristics under forward bias.

5 marks

QUESTION 4 (15 MARKS) – OPTIONAL

- a) For the MOSFET biasing circuit below, calculate (i) V_{GS} and (ii) V_{DS} for $I_{DS} = 60\text{mA}$.



4 marks

- b) Explain how a depletion region is created at a p-n junction and state the kind of particles that are found in the depletion region.

8 marks

- c) Why are holes never found in the conduction band?

3 marks