



# MACHAKOS UNIVERSITY

University Examinations 2022/2023 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR SECOND SEMESTER EXAMINATION FOR  
BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)  
SPH 308: SOLID STATE PHYSICS

DATE: 11/4/2023

TIME: 8:30 – 10:30 AM

## INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).

Answer question ONE and any other TWO questions

## SECTION A (COMUPULSORY)

### QUESTION ONE (30 MARKS)

- a) Figure 1 shows a form of a diode. State its name, draw it symbol and define it.

(3 marks)

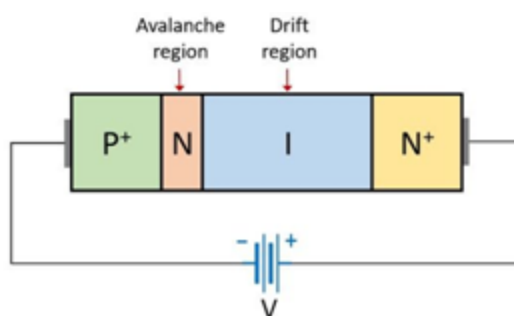


Figure 1

- b) Draw a structure and symbol of a schottky diode (2 marks)
- c) Explain how conductivity of a semiconductor material behave at
- absolute zero temperature
  - room temperature
  - high temperatures

(3 marks)

- d) When an intrinsic semi conductor is doped with a trivalent element like phosphor, the resulting crystal is said to be electrically neutral, explain why? (3 marks)
- e) Explain how the depletion layer in a p-n junction diode is made (3 marks)
- f) Figure 2 shows a full wave rectifier. Show position where a capacitor can be installed in the circuit. State also the role played by the capacitor. (3 marks)

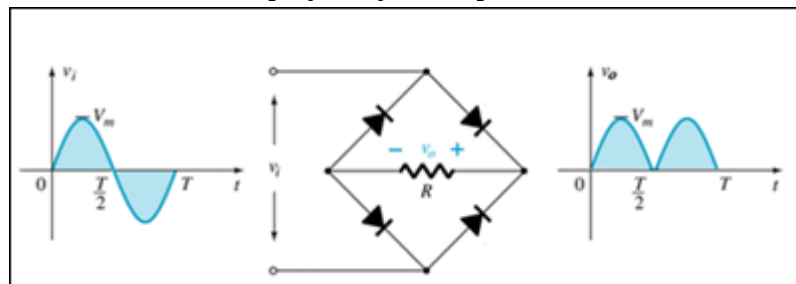


Figure 2

- g) LASER is an acronym for “Light amplification by stimulated emission of radiation”. Explain how this stimulation takes place. (2 marks)
- h) Draw the symbol for a LED and LASER diode (2 marks)
- i) Distinguish between a light emitting diode and a laser diode based on  
i) architecture  
ii) output characteristics (4 marks)
- j) Justify the application of a TRIAC in a.c rectification over a SCR (3 marks)
- k) With a diagram, explain the I-V characteristics of an IMPATT diode (2 marks)

## SECTION B

### QUESTION TWO (20 MARKS)

- a) SCR is an acronym for a silicon controlled rectifier  
i) state four of its functions (4 marks)  
ii) Draw well labelled figures showing its architecture and symbol (4 marks)
- b) Imagine you are constructing a siren based burglar alarm. Suppose the siren is rated as 1000 W and 48 V. The panels in the market are rated as 12 V 5 A. Draw a circuit showing your burglar alarm set up. (6 marks)
- c) Explain two energy loss mechanisms that lower efficiency of a solar cell (6 marks)

### QUESTION THREE (20 MARKS)

- a) The working principle of a solar cell is in reverse to that of a LED and under goes three steps. Describe the three steps with well illustrated diagrams (9 marks)
- b) Distinguish between photo electric effect and photovoltaic effect (4 marks)
- c) Show that in a transistor base to collector current gain  $\beta_{dc}$  is related to emitter-to-collector current gain  $\alpha_{dc}$  by  $\alpha_{dc} = \frac{\beta_{dc}}{1 + \beta_{dc}}$  (7 marks)

#### QUESTION FOUR (20 MARKS)

- a) Most of devices used in our homes and offices consume d.c and these calls for a.c rectification. Why then, cant Kenya power and lighting company transmit electricity as d.c (2 marks)
- b) Define a solid state device in context of
- i) computers
  - ii) electronics and give three examples in each case (6 marks)
- c) Draw solar IV characteristic curves in a common axis for
- i) a single cell,
  - ii) for two cells in parallel and
  - iii) for two cells in series (6 marks)
- d) Given that  $\beta_{dc} = 14.9$ ,  $I_c = 8.7\text{A}$ , find  $I_E$ ,  $I_B$  and  $\alpha_{dc}$  (6 marks)

#### QUESTION FIVE (20 MARKS)

- a) The working principle of a light emitting diode is based on quantum theory of light. Explain it. (2 marks)
- b) Define the following terms
- i) Semi conductor
  - ii) Extrinsic semiconductor
  - iii) inhomogeneous semiconductor (6 marks)
- c) Define the following terms
- i)  $V_{oc}$
  - ii)  $I_{sc}$
  - iii) Maximum power point (6 marks)
- d) Calculate  $I_E$  and  $I_B$  for a transistor whose  $\alpha_{dc} = 0.97$  and  $I_c = 0.65\text{ mA}$ . What is  $\beta_{dc}$ ? (6 marks)