MACHAKOS UNIVERSITY

University Examinations 2022/2023

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: **TIME:**

Instructions

Answer question ONE and any other TWO questions

QUESTION ONE (30 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) The working principle of a light emitting diode is based on quantum theory of light. Explain how it happens. (2 marks)

c) Define the following terms:
   i) IMPATT (2 marks)
   ii) Schottky (2 marks)

d) Explain how conductivity of a semiconductor material behave at
   i) Absolute zero temperature
   ii) room temperature
   iii) high temperatures (3 marks)

e) When an intrinsic semiconductor is doped with a pentavalent element like phosphor, the resulting crystal is said to be electrically neutral, explain? (3 marks)

f) Explain how the depletion layer in a p-n junction diode is made (3 marks)

g) Draw a circuit that can be used for full wave a.c rectification (3 marks)

h) What does the acronym LASER stand for (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 (2 marks)

k) With a diagram, explain the I-V characteristics of an IMPATT diode (2 marks)

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)

iii) Using a diagram, explain working principle of a SCR. (6 marks)

b) Explain two energy loss mechanisms that lower efficiency of a solar cell. (6 marks)

QUESTION THREE (20 MARKS)

a) Draw the structure and symbol of a schottky diode (2 marks)

b) Define the following terms:

i) Semi-conductor

ii) Extrinsic semiconductor

iii) inhomogeous semiconductor (6 marks

c) Sketch solar IV characteristics and explain how they can be used to design a solar circuit to perform at optimum conditions (6 marks)

d) Calculate I_E and I_B for a transistor whose α_{dc} = 0.98 and I_C = 0.75 mA. What is β_{dc}? (6 marks)

QUESTION FOUR (20 MARKS)

a) Draw the symbol for a LED and LASER diode (2 marks)

b) Define a solid state device in the following contexts and give three examples in each case.

i. computers

ii. electronics (6 marks)

c) Draw solar IV characteristic curve in a common axis for a single cell, for two cells in parallel and for two cells in parallel (6 marks)

d) Given that β_{dc} = 5.9, I_c = 3 mA, find I_E, I_B and α_{dc} (6 marks)

QUESTION FIVE

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 β_{dc} is related to emitter-to-collector current gain α_{dc} by $\alpha_{dc} = \frac{\beta_{dc}}{1+ \beta_{dc}}$ (7 marks)