MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPH 306: SOLID STATE PHYSICS

DATE: 10/12/2021 **TIME: 2:00 – 4:00 PM**

INSTRUCTIONS

Answer question ONE and any other TWO questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define the following terms diodes
i) IMPATT diode ii) Schottky diode (4 marks)

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

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

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

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

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

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

h) Distinguish between a light emitting diode and a laser diode based on
i) architecture
ii) output characteristics (4 marks)

i) Justify the application of a TRIAC in a. c rectification over a SCR (2 marks)

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

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

QUESTION TWO (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) 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} = 0.97 and I_C = 0.65 mA. What is β_{dc}? (6 marks)

QUESTION THREE (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 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} = 4.9, I_c = 4 mA, find I_E, I_B and α_{dc} (6 marks)

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

QUESTION FIVE (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)