



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**FOURTH YEAR FIRST SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS**

**FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN ELECTRICAL AND
COMMUNICATIONS ENGINEERING**

COURSE CODE: ECE 415

COURSE TITLE: POWER ELECTRONICS 1

**DATE: TUESDAY, October 4TH, 2022
PM**

TIME: 12.00 - 2:00

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over. ►

QUESTION ONE

(a) Define the term power electronics and explain any two of its applications.

(4marks)

(b) Describe the following power diodes

i. General purpose diodes.

ii. High speed (fast recovery) diodes.

iii. Schottky diode

(6 marks)

(c) Using relevant diagrams explain the three basic modes of operation of an SCR (9 marks)

(d) An SCR is triggered from a 16V source, the loadline has a slope of -100V/A . The minimum gate current for successful triggering is 20 mA. Find

(i) Source resistance

(ii) Trigger current

(iii) Voltage for the gate power dissipation of 0.4W

(7 marks)

(e) A single phase 200 V, 1kW heater is connected across a one phase, 240, 50 HZ supply through an SCR. For firing angle delays of 45° and 90° , calculate the power absorbed in the heater element

(6marks)

QUESTION TWO

(a)(i) Explain what is meant by the term dual converter

(1 mark)

(ii) Discuss the operation of an ideal dual converter, include relevant expressions of voltage outputs

(9 marks)

(iii) State the two main effects of source impedance on performance of converters

(3 marks)

(b) A single phase circulating current dual converter is fed by a 240 V single phase, 50HZ AC supply. The load is purely resistive. The peak current of converter 1 is 30 A. The firing angles are 45° and 135° respectively. If the peak circulating current is 12.5 A. Compute

- (i) The Inductance of current limiting reactor (5 marks)
- (ii) The resistance of the load (2 marks)

QUESTION THREE

(a) Describe the following types of transistor base drive configurations

- (i) Non isolated base driver circuit (4 marks)
- (ii) Base command without negative power supply (3½marks)
- (iii) Ant saturation diodes (Bakers clamp)
(3½marks)

b) The β of a bipolar transistor varies from 12 to 75. The load resistance is $R_C = 1.5 \Omega$.

The dc supply voltage is $V_{CC} = 40V$ and the input voltage base circuit is $V_B = 6V$. If

$V_{CE(sat)} = 1.2V$, $V_{BE(sat)} = 1.6V$ and $R_B = 0.7 \Omega$ determine

- i. The overdrive factor ODF. (3marks)
- ii. The forced β_f (3marks)
- iii Power loss in transistor PT (3marks)

QUESTION FOUR

(a) Define the following terms as they are applied to silicon controlled rectifier

- (i) Latching current (1 mark)
- (ii) Holding current (1 mark)

(b) Explain any three advantages of Gate Turn off Thyristor (GTO) over SCR (3 marks)

(c) Using a well labelled diagram explain how current sharing in parallel connected transistors is accomplished using coupled indicators (5marks)

(d) Explain the three main firing circuit requirements for SCR (4½marks)

(e) The V_g - I_g characteristics an SCR is given by $V_g = 1 + 9 I_g$ the gate pulses are rectangular with an amplitude of 20V and duration of 40 μs . The duty cycle is 0.4

(i) Find the series resistance R_g in the gate circuit to limit the peak power loss to 6W

(3 marks)

(ii) Find the average gate power loss

(2 marks)

QUESTION FIVE

(a) (i) using a power circuit diagram, voltage and current waveforms explain the working of a single phase half wave controlled rectifier with RL load and freewheeling diode (9 marks)

(ii) State any three advantages of using freewheeling diode in a(i) (3 marks)

(b) (i) Draw a well labelled a diagram of a single phase dual converter (4 marks)

(ii) A single phase dual convertor is operated from 240V, 50 Hz supply, and the load resistant is $R=20\ \Omega$. The circulating inductance is $L_v=50\text{mH}$, delay angles are $\alpha=130^\circ$, find the peak circulating current and peak current of converter 1 (4 marks)