70

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER EXAMINATIONS

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

COURSE CODE: ECE 415

COURSE TITLE: POWER ELECTRONICS 1

DATE: TUESDAY, APRIL 26TH, 2022 **TIME: 3:00 - 5:00 PM**

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

QUESTION ONE

(a) Define the term power electronics (2marks)

(b) Describe the following power semiconductor devices stating advantages in each case

(i) Power diodes

(ii) Power transistors (BJTs)

(iii) Thynstors (6 marks)

(c) Name and explain the three basic modes of operation of an SCR (9 marks)

(d) An SCR is triggered from a 12v source, the loadline has a slope of -100V/A. The minimum gate current for successful triggering is 18mA. Find

(i) Source resistance

(ii) Trigger current

(iii) Voltage for the gate power dissipation of 0.2W (7 marks)

(e) A single phase 20v, 1kw heater is connected across a one phase, 220, 50 HZ supply through an SCR. For firing angle delays of 45^{o} and 90^{o}, calculate the power absorbed in the heater element (6marks)

QUESTION TWO

(a)(i) Define the term dual converter (1 mark)

(ii) Using a diagram explain 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 220 V single phase, 50HZ AC supply. The load is purely resistive. The peak current of converter 1 is 40 A. The firing angles are 45^{o} and 135^{o} respectively. If the peak circulating current is 12.5 A. Find

(i) Inductance of current limiting reactor (5 marks)

(ii) Load resistance (2 marks)

QUESTION THREE

(a) Explain any two main requirements that base drive circuits try to satisfy in an electronic circuit (2 marks)

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

(i) Non isolated base driver (4 marks)

(ii) Base command without negative power supply (3½marks)

(iii) Ant saturation diodes (Bakers clamp)
(3½marks)

(iv) Isolated base drive circuit (3.5 marks)

(v) Transformer coupled base drive with tertiary winding transformer (3 marks)

QUESTION FOUR

(a) Define the following terms as they are applied to thyristors

(i) Latching current 9 (1 mark)

(ii) Holding current (1 mark)

(b) State 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 Vg-I g characteristics an SCR is given by Vg = 1+9 Ig the gate pulses are rectangular with an amplitude of 15V and duration of 40 μs. The duty cycle is 0.3

(i) Find the series resistance Rg 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 (3 marks)

(b) (i) Draw a well labelled a diagram of a three phase dual convertor (4 marks)

(ii) A single phase dual convertor is operated from 200v, 50HZ supply, and the load resistant is R= 20 SL. The circulating inductance is Lv= 50Mh, delay angles are $\alpha 2 = 130^{o}$ find the peak circulating current and peak current of converter 1 (4 marks)