



(University of Choice)
**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

FOURTH YEAR SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATIONS

**FOR THE DEGREE
OF
BACHELOR OF TECHNOLOGY EDUCATION IN ELECTRICAL AND ELECTRONICS
ENGINEERING**

COURSE CODE: TEE 424

COURSE TITLE: POWER ELECTRONICS

DATE: Thursday, 06th October, 2022

TIME: 12.00 – 02.00p.m

INSTRUCTIONS TO CANDIDATES

Answer Question ONE and any other TWO (2) questions

Marks will be awarded for correct working even if the answer is wrong

MMUST observes ZERO tolerance to examination cheating

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

QUESTION ONE - COMPULSORY (30 MARKS)

- a) A half-wave rectifier is used to supply $50 V_{dc}$ to a load resistive load of 800Ω . The diode has a resistance of 25Ω . Calculate the a.c voltage required. (4 marks)
- b) Draw the emitter characteristics of a UJT. Describe what you infer from your graph. (10 marks)
- c) A half-wave rectifier is used to supply $50 V_{dc}$ to a load resistive load of 800Ω . The diode has a resistance of 25Ω . Calculate the a.c voltage required. (4 marks)
- d) A thyristor has a linearized gate-cathode characteristic of slope $25 V/A$. A gate current of $200 mA$ turns the thyristor ON in $16 \mu s$. The gate source voltage is $10 V$. The manufacturer's average maximum power for the gate is $400 mW$. If pulse firing is used, calculate: (6 Marks)
- i) The value of the gate series resistance
 - ii) The gate power dissipation during turn-on
 - iii) The frequency of the gate pulses
- e) Find the voltage V_Q and current I_D in the network shown in Figure Q1.1 using a simplified model. (3 Marks)

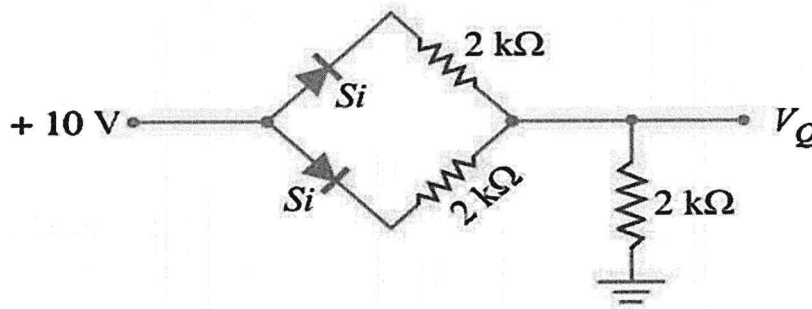


Figure Q1.1

- f) Determine the maximum and minimum peak-point voltage for a UJT with $V_{BB} = 25 V$. given that the UJT has a range of $\eta = 0.74$ to 0.86 . (4 marks)
- g) A chopper supplied by a $200 V_{dc}$ has an ON time of $30 ms$ and an OFF time of $10 ms$. Determine the value of the average dc output voltage. (3 Marks)

QUESTION TWO (20 MARKS)

- a) With the aid of relevant diagrams, describe in detail the construction and operation of an IGBT. (10 Marks)

- b) Figure Q2.1 shows a schematic of a power control circuit. What type of circuit is this? Describe the operation of this circuit and sketch the output waveforms. (10Marks)

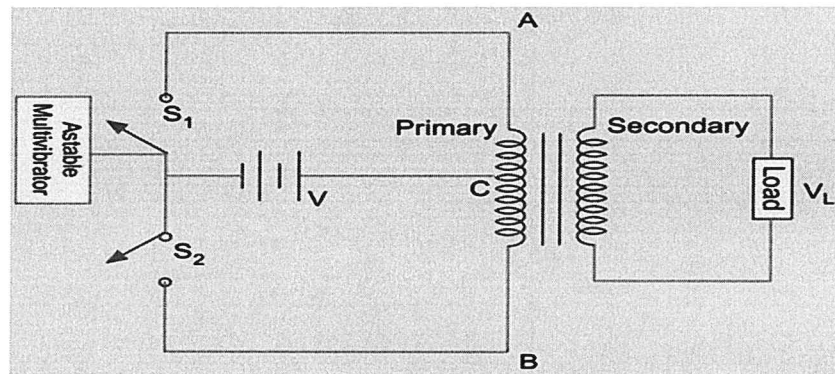


Figure Q2.1

QUESTION THREE (20 MARKS)

- a) In a controlled half-wave rectifier, the peak power supply voltage is given by $v = V_m \sin \theta$. Derive the average values of voltage and current for such a controlled half-wave rectifier for a firing angle of 90° using relevant schematic and output voltage graph. (10 marks)
- c) Draw the transistor equivalent circuit of a Triac and explain its operation from this equivalent circuit. (10 Marks)

QUESTION FOUR (20 MARKS)

- a) The excellent electric braking methods are available which eliminate the need of brake lining levers and other mechanical gadgets. Using relevant schematics, describe the Rheostatic or dynamic braking method used for shunt motors. (10 Marks)
- b) An IRF 150 power MOSFET has $V_{DD} = 20 \text{ V}$, $R_1 = 0.5 \Omega$; at $V_{GS} = 8 \text{ V}$, the ON-state resistance is 0.1Ω . Determine the values of the load current, device voltage drop, load power and circuit efficiency. (10 Marks)

QUESTION FIVE (20 MARKS)

- a) With the aid of a relevant schematic, describe thyristor speed control of a DC series motor. (10 arks)
- b) Using a simple possible single-phase input to single-phase output with a pure resistance as a load, describe the principle of the cycloconverter. (10 marks)

