# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2021/2022 ACADEMIC YEAR

**THIRD** YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

UNIT CODE: EET 307

UNIT TITLE: POWER ELECTRONICS

DURATION: 2 HOURS

**INSTRUCTIONS TO CANDIDATES:**

1. Answer question One and Any Other Two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

**SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION**

**QUESTION ONE (20 MARKS)**

(a) A thyristor has linearized gate –cathode characteristic of sloped 25 V/A. A safe current of 200mA turns the thyristor ON in 64s. The safe source voltage is 10V. The manufacturer's average maximum power from the gate is 4000mW. If pulse firing is used, calculate: (6 marks)
   (i) The value of the gate series resistance
   (ii) The safe power dissipation during turn-ON
   (iii) The frequency of the safe pulses.

(b) Find the voltage $V_Q$ and current $I_D$ in the network shown in Figure Q1.1 using a simplified model. (3 marks)

(c) An IRF 150 power MOSFET has $V_{DD}$ = 20V, $R_1$ = 0.5Ω; at $V_{GS}$=8V, the ON-state resistance is 0.1Ω. Determine the values of the load current, device voltage drop, load power and circuit efficiency. (10 marks)

(d) Determine the maximum and minimum peak-point voltage for a UJT with $V_{BB}$ = 25V, given that the UJT, has a range of $\eta$ = 0.74 to 0.86. (4 marks)

(e) A half-wave rectifier is used to supply 50Vdc to a load resistive load of 800Ω. The diode has a resistance of 25Ω. Calculate the a.c voltage required. (4 marks)

(f) A chopper supplied by a $200V_{dc}$ has an ON time of 30ms and an OFF time of 10ms. Determine the value of the average dc output voltage. (3 marks)

**SECTION B ANSWER ANY TWO QUESTIONS IN THIS SECTION**

**QUESTION TWO (20 MARKS)**

(a) Draw the transistor equivalent circuit of a Triac and explain its operation from the equivalent circuit. (10 marks)

(b) With the aid of relevant diagrams describe in detail the construction and operation of either (10 marks)
   (i) An IGBT
   or
   (ii) Power MOSFET
   Or
   (iii) Power transistor

**QUESTION THREE (20 MARKS)**

(a) Using a simple possible single phase input to sing –phase output with a pure resistance load, describe the principle of the cyclo-converter. (10 marks)

(b) In a controlled half wave rectifier, the peak power supply is given by $V= V_m Sin\theta$. Derive the average values of voltage and current for such a controlled rectifier for a firing angle of $90^o$ using relevant schematics and output voltage graphs. (10 marks)

**QUESTION FOUR (20 MARKS)**

(a) With the aid of a relevant schematic, describe thryristor speed control of a DC series motor. (10 marks)

(b) Figure Q4.1 shows a schematic of a power control circuit. What type of circuit is this? Describe the operation of this circuit and sketch the output waveform. (10marks)