



MURANG'A UNIVERSITY COLLEGE

(A Constituent College of Jomo Kenyatta University of Agriculture and Technology)

MAIN EXAMINATION

DEPARTMENT: ELECTRICAL ENGINEERING
LEVEL: DIPLOMA
CLASS: MRUC/EEP/14DJ
SEMESTER: 2
ACADEMIC YEAR: 2014/15
YEAR OF STUDY: 2
UNIT: INDUSTRIAL ELECTRONICS
UNIT CODE: SEE1211
DATE: 24TH APRIL

TIME: 2 HOURS

Instructions to candidates

This paper contains four (4) Questions

Attempt question **one** and any other (2) questions

You should have the following for this examination;

- Drawing instruments
- Scientific calculator

➤ **NO MOBILE PHONES ARE ALLOWED WITHIN THE EXAMINATION ROOM!!!!!!!**

QUESTION 1: (30 marks)

- (a). State any *two* methods of turning on Thyristor. [2mrks]
- (b). With the aid of characteristic curve, explain the operation of a TRIAC [3mrks]

- (c). With the aid of relevant circuit diagrams and wave forms, explain the principle used in forced commutation of SCRs. [3mrks]
- (d). If the rectifier in figure 1 has a purely resistive load R, determine (i) the efficiency, (ii) the form factor FF, (iii) the ripple factor RF, (iv) the transformer utilization factor TUF and (v) the peak inverse voltage PIV (vi) the input power factor PF [8mrks]

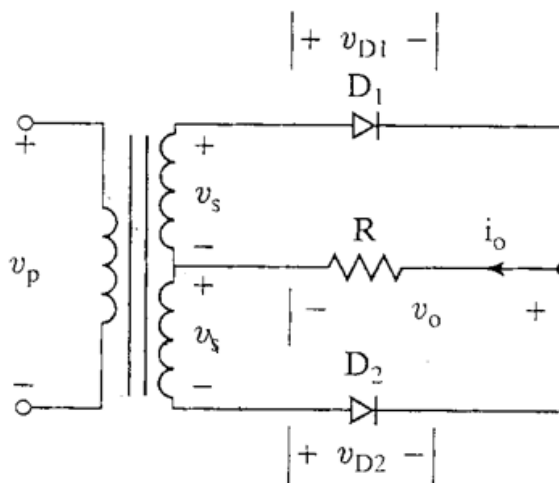


Figure 1

- (e). List two methods of voltage control employed in ac voltage controllers. [2mrks]
- (f). Draw the power circuitry for a single-phase bridge controlled converter and explain its operation with relevant waveforms. Derive the expression for average load voltage assuming continuous current operation. [5mrks]
- (g). List two advantages of DC drives over AC drives [2mrks]
- (h). A dc drive works at 1100rpm when fed from a 220V dc source. The same drive is supplied from a chopper connected to 220V dc mains. What will be the duty ratio to obtain 900 r.p.m. Neglect the $I_a R_a$ drop. [3mrks]

QUESTION 2: (20 marks)

- (a). For a single phase ac voltage controller feeding a resistive load, draw the waveforms of source voltage, gating angle, output voltage, source and output currents and voltage across the SCRs. Describe its working with reference to the waveforms drawn. [10mrks]
- (b). Differentiate between ON-OFF control and phase control of a converter? [2mrks]
- (c). An ac voltage regulator operating from 230V, 50Hz supply uses integral cycle control to control the flow of power to 10Ω load. The thyristors conduct for 18 cycles and remain off for 32 cycles.
Find

- (i). rms value of output voltage

- (ii). power output to the load
- (iii). input power factor
- (iv). average and rms values of SCR current (neglect losses). [8mrks]

QUESTION 3: (20 marks)

- (a). Draw the circuit of a dc chopper with RL load and explain its operation with waveforms. [4mrks]
- (b). A step down dc chopper is connected to a resistive load of 30Ω . The dc supply voltage is 200V. The duty ratio of the chopper is 0.8 with a chopping frequency of 400Hz. Determine the average load voltage, average load current and ON time of the chopper. [8mrks]
- (c). A buck-boost converter is to supply a maximum power of 75 W at -50 V from a 40 V dc source. The output voltage ripple must be no more than 1%. The switching frequency f_s is 40 kHz. Assume that the converter operates at the boundary of continuous/discontinuous conduction mode when 75W is supplied.
- (i). Calculate the duty cycle D .
 - (ii). Calculate the required size of the inductance L and capacitance C .
 - (iii). Determine the average, maximum and minimum inductor currents.
 - (iv). Sketch the diode current waveform and find its average value.

[8mrks]

Question 4: (20 marks)

- (a). A 3-phase star rectifier is operated from 460 V 50 Hz supply at secondary side and the load resistance is $R=20\Omega$. If the source inductance is negligible, determine
- (a) Rectification efficiency,
 - (b) Form factor
 - (c) Ripple factor
 - (d) Peak inverse voltage (PIV) of each diode.
- [10mrks]
- (b). Draw the power circuitry for IGBT based single-phase bridge inverter and explain its operation with relevant waveforms. [4mrks]
- (c). A three-phase bridge inverter is fed from a dc source of 200V. If the load is star connected with 20Ω resistance per phase obtain the value of
- (i) rms load current
 - (ii) rms current rating of thyristors
 - (iii) The load power for 120° conduction and 180° conduction [6mrks]