MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 508: POWER ELECTRONICS AND VARIABLE SPEED DRIVES

DATE: 19/10/2020 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

a) State the three conventional methods of speed control in D.C motors. (3 marks)

b) The speed of a separately excited D.C motor is controlled by a single phase full wave converter, the field circuit is also controlled by a full wave converter and field current is set to maximum value. The A.C supply voltage to armature and the field is one phase 440 volts, 60 Hz. The armature resistance R_a = 0.25Ω, the field resistance R_f = 175Ω, the motor constant K_m = 1.4V/A rads/sec, the armature current corresponding to the load demand is I_a= 45 amperes. The viscous friction and no load losses are negligible, the inductance of the armature and the field circuit are sufficient to make the armature and field current continues and ripple free. Take $\alpha_a = 60^0$.

(i) The torque developed by the motor.

(ii) The speed in rev/min

(iii) The input power factor of the drive (12 marks)

c) With the aid of a circuit diagram and output waveforms show that the steady state discontinues voltage applied to the armature terminal of a single phase fully controlled rectifier fed D.C drive is given by

$V_a = \{ \frac{V_{max}}{\pi} (\cos \alpha - \cos \beta) + \frac{E_b}{\pi}(\pi + \alpha - \beta)$ (12 marks)

d) State any three applications of D.C choppers (3 marks)

QUESTION TWO (20 MARKS)

a) Draw a circuit diagram of anti-parallel SCR, hence describe its operation as applied in reversal of speed of D.C motor. (6 marks)

b) A separately excited D.C motor is driven by a three phase fully controlled converter with a contactor for speed reversal. The line voltage is 440 volts, 50HZ. The motor armature resistance is 0.12Ω and the armature voltage constant is 2v/rad/sec at the rated field current. Determine:

(i) The firing angle necessary at the armature current of 40Amps and speed of 1500RPM.

(ii) The required delay angle required to get armature current to 40A for regenerative braking if contactor is operated after a delay angle control is used to bring the armature current to zero and the start of the sequence of speed reversal.

(iii) Regenerative braking power

(iv) Braking torque (14 marks)

QUESTION THREE (20 MARKS)

a) With an aid of a diagram, describe the operation of a regenerative braking D.C chopper as applied in D.C motors. (8 marks)

b) A D.C chopper is used to control the speed of a separately excited D.C motor. The D.C supply is 330 volts. The armature resistance is 0.26Ω and the motor constant is 0.98v/rad/sec. the motor drives a constant load torque of 115NM. If the field current is held constant at 1.5A, assuming no load losses, determine the range of speed control for the motor (8 marks)

c) Draw a circuit diagram of a four quadrant D.C chopper. (4 marks)

QUESTION FOUR (20 MARKS)

a) Draw a closed loop control system of a D.C drive (5 marks)

b) With an aid of a schematic block diagram, derive a closed loop transfer function of a D.C motor which relates the output speed to input voltage. (15 marks)

QUESTION FIVE (20 MARKS)

a) State the three advantages of A.C drives (3 marks)

b) With the aid of a circuit diagram, describe the operation of a self-controlled three phase synchronous motor fed from a load commutated thyristor inverter. (9 marks)

c) A three phase 11.2kw, 1750RPM, 460Volts, 60HZ, 4-pole star connected induction motor has the following parameters; R_s = 0.66Ω, R_r'= 0.38Ω, X_r' = 1.71Ω, X_m = 33.2Ω. the motor is controlled by varying both the voltage and the frequency. The volts/Hertz ratio which corresponds to the rated voltage and voltage is maintained constant. Determine the maximum torque and maximum speed for a frequency of 60 HZ. (8 marks)