TECHNICAL UNIVERSITY OF MOMBASA

FACUULTY OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTRMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

EEE2513: ELECTRICAL MACHINE DRIVES

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: SEPTEMBER 2018

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a)

i. Explain the main purpose of an electrical drive

ii. Explain the significance of rectification and inversion in electrical drives

iii. State any THREE roles of an instrumentation circuit in an electrical drive

(6 Marks)

b) Sketch block diagram showing Field Oriented Control(FOC) technique for electrical drives and explain how it works

(9 Marks)

c)

i. State TWO advantages and TWO disadvantage of cyclo-converter drives over inverter drives

ii. Explain unique applications for DC and AC drives respectively

(6 Marks)

d) Sketch the equivalent circuit of an Induction motor and show that in variable voltage constant frequency drives the torque output is given by:

$T_0 = [kV]^2$

Hence

i. determine the toque output for 15hp,415V, 730rpm,50Hz induction motor when the control signal k=0.25, 0.5 and when k=0.65 and 1 respectively:

ii. Sketch the Torque speed characteristic above assuming the motor was of NEMA class D

(9 Marks)

Question TWO

a) Highlight any SIX factors to consider while selecting an electric drive for a certain application

(6 Marks)

b) Sketch a Current Source Inverter Circuit(VSI) for a 3-φ synchronous motor, and explain the function of each section

(6 Marks)

c) A 150$V_{l\text{-}n}$,10A, 40Hz, 1- φ, 0.85pf motor is fed via a four step inverter circuit from a 3- φ, 240 $V_{l\text{-}n}$ supply. Assuming modulating index m_a of 0.7, calculate:

i. The DC section voltage and current

ii. The source side fundamental current and power factor

iii. The source side fundamental current and power factor if source is replaced by 415$V_{ll,}$ 3- φ supply

(8 Marks)

Question THREE

a) Describe scalar and vector modelling of electrical drives

(4 Marks)

b)

i. List any FOUR parameters considered in a dynamic model for electrical drives

ii. State TWO advantages of space phasor models over dynamic models in electrical drives

(6 Marks)

a) Two phase quadrature currents displaced from fixed reference frame by θ=30^o and each having peak value of 200 A are fed to a three phase machine with balanced supply. Sketch the layout of such a drive system and determine:

i. **αβo** component output with **dqo** input

ii. **abc** component output from **αβo** block

iii. the layout sketch corresponding to drive in b(i) and b(ii) above

(10 Marks)

Question FOUR

a) State THREE:

i. Advantages of DC Chopper drives over DC Silicon Controlled Rectifier(SCR)

ii. Problems of SCR drives

(6 Marks)

b) Sketch bock diagram of DC SCR drive system and explain how it functions

(6 Marks)

c) A 220V, 20A, 500r.p.m. armature current controlled separately excited DC motor having armature resistance of 0.5Ω is to be connected to a 3-φ 415V mains through a Δ-Δ step down transformer and a SCR drive. Determine transformer ratio applied and the firing angle required for:

i. forward motoring operation at 500rpm
ii. forward braking at 300rpm

(8 Marks)

Question FIVE

a) Using sketches distinguish between unipolar and bi-polar wave drives for stepper motors

(4 Marks)

b) Estimate the number of pulses and pulse frequency per phase output by a 6-phase wave drive supplying a stepper motor having 12 stator poles and 10 rotor poles, and is required to rotate a 21cm diameter wheel through a distance of 6.6m in 5 seconds.

(6 Marks)

c)

i. Show that the transfer function of a Field Controlled Servo Motor is given by:

$$\frac{\theta_o(s)}{V_F(s)} = \frac{K_F K_m / L_F J_m}{s(s + D_m/J_m)(s + R_f/L_f)}$$

ii. Determine the steady state angular displacement for the motor in b(i) above when supplied with a 100V 25ms pulse input. The parameters of the machine are:
L_f= 100H, R_f=0.5kΩ, K_f =10, J_m=0.01Kgm^{2}s^{-2}, D_m=0.04N/ms^{-1}, K_m=50

(10 Marks)