TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 4417: ELECTRICAL MACHINES IV

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2024

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

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 and carry 30 Marks. Each of other question carries 20 marks. Attempt any THREE Questions.

Do not write on the question paper.

Question ONE

a) State any
   i. FIVE general applications of micro electrical machines.
   ii. FIVE characteristic features of mini and micro electrical machines.

(10 Marks)

b)
   i. Sketch a diagram of Round and Linear Induction Motor and explain.
   ii. State any FOUR applications of LIMs.

(10 Marks)

c) An overhead crane in a Factory is driven horizontally by means of two similar Linear Induction Motors(LIMs), whose rotors are the two steel I-beams, on which the crane rolls. 3-phase, 4-pole LIM stators, are mounted on the opposite sides of the crane, have a pole-pitch of 60mm and are energized by a variable-frequency electronic source. When one of the motors was tested, it yielded the following results: Stator frequency=25Hz; Stator copper and Iron loss=1.2kW; Power to stator=6kW; Crane speed=2.4m/s. Calculate:

i. Synchronous speed and slip
ii. Power input to rotor
iii. Copper losses in the rotor
iv. Gross mechanical power developed
v. Thrust

(10 Marks)

Question TWO

a)

i. Sketch a circuit diagram for energizing a switched PM microsynchronous machine in Bipolar Mode.
ii. State any FIVE application areas for stepping micromachines.

(8 Marks)

b) A 2 kW, 400 V, 150 Hz Permanent Magnet Servo Motor(PMSM), hasrelative synchronous inductance Ld = 0.2H. Both the power factor and the efficiency of the motor are 0.9. A DTC inverter applies a minimum pulse of 25 μs. Find:

i. rated impedance and current rating
ii. Rated inductance of machine and estimated synchronous inductance
iii. DC intermediate voltage and current rise rate
iv. The minimum pulse width(duration)

(12 Marks)

Question THREE

a)

i. Sketch a diagram of an Amplydyne and corresponding phasor diagram.
ii. State any FOUR industrial applications of Amplidynes.

(10 Marks)

b) A 2.5mWb, 4 pole, 50 conductor, wave wound, Permanent Magnet(PM), Tachometer has a sensitivity of 5V/1000 rpm. Find

i. The Gain Constant

ii. Machine constant.
iii. Voltage output change corresponding to speed change from 300-750rpm

(10 Marks)

Question FOUR

a)

i. State any FOUR applications of Synchros.
ii. Explain the difference between a sychro and a rotary transformer.

(8 Marks)

b) The outputs of the resolver with a converter reference setting of 115V is fed into a Synchro format by a Scott connected to 90V, 1.3VA Current Transformer,calculate the line voltage and minimum MVA

(6 Marks)

c) A positional control system in **Fig. Q4** below: The error signal is applied to the differential amplifier which gives input to the servomotor.

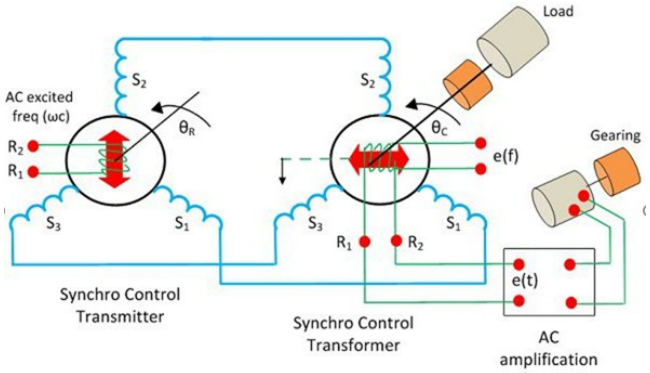

Fig Q4

i. Show that error equation e(t)= K'Vrcos$\vartheta \sin \omega_c t$
ii. Sketch the relative response of angle, voltage and error signal

(6 Marks)

Question FIVE

a)

i. Sketch a diagram of a 3-phase Single Stack Variable Reluctance(SSVR) stepper motor with 4 rotor teeth.
ii. Explain the operation of the stepper motor in (i) above.

(8 Marks)

b) A stepper motor advances 2.5º per step. Calculate the number of pulses and pulse frequency needed to complete 25 revolutions:
    i. Full step operation is 5 seconds
    ii. For half step operation in 2 minutes

(12 Marks)