TECHNICAL UNIVERSITY OF MOMBASA

FACUULTY OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTRMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE2415: ELECTRICAL MACHINES V

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

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. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) State FOUR unique applications of specialized machines

(4 Marks)

b)

i. With the aid of a sketch Explain how a DC Tacho-generator functions.

ii. A Tachometer outputs 10 V when measuring a motor shaft speed rotating at 300rpm. Determine the tachometer sensitivity and output voltage when the speed reduces to 200rpm.

(9 Marks)

c)

i. Sketch and label winding configurations of un-compensated and compensated universal motors

ii. State the applications of the motors above and give reasons

(6 Marks)

d) State the differences existing between:
   i. Torque Transmitter and Control Transmitter
   ii. Torque Differential Receiver and Torque Receiver Transmitter

e) Figure 1 below is a sketch of Transmitter

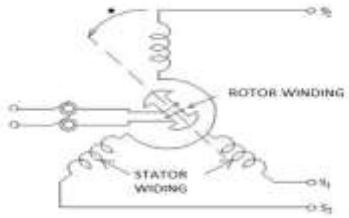

Figure 1

Show that the outputs E_{S12}, E_{S23} and E_{S31} are given by:

$$E_{s12} = \sqrt{3}KE_r \sin(\vartheta + 240)\sin \omega t$$
$$E_{s23} = \sqrt{3}KE_r \sin(\vartheta + 120)\sin \omega t$$
$$E_{s31} = \sqrt{3}KE_r \sin(\vartheta).\sin \omega t$$

Hence determine the transmitted voltages corresponding to rotor displacement of 30^o when supplied with 240Vrms. Take the instant to correspond with $\omega t = \pi/2$, and unity K

(11 Marks)

Question TWO

a)
   i. With the aid a sketch, explain how AC single phase motor servo system works
   ii. State THREE advantages of the system above over DC servo systems

(8 Marks)

b) Show that the torque output of armature controlled DC servo motor having gear transmission system is given by:

$$T_o = 0.1592\left(\frac{Z * P}{C}\emptyset I_a\right)\frac{Radius_{shaft}}{Radius_{wheel}}$$

Hence determine the torque output and work done through 30^o of a DC servo-system having the following particulars and output provided through ball screw system:

Motor particulars: *Wave wound; Armature current:20A; Armature conductors: 1000, Poles:8; Field Voltage: 50V; Field Resistance: 0.5kΩ; Field Reluctance: 2k$\Omega_{magnetic}$; Number of field turns: 200*

Ball screw mechanism particulars: *Mass moved: 10kg; Coefficient of friction; μ: 0.25, Ball screw radius: 0.01m, efficiency: 90%; Motor shaft radius:0.005m; Gear wheel radius 0.06m.*

(12 Marks)

Question THREE

a)

i. Draw a sketch of an Induction Voltage Regulator(IVR) and explain how it functions.

ii. State TWO problems in power transmission lines having induction voltage regulators

(8 Marks)

b) An Induction Voltage Regulator is applied for voltage regulation at the end of a 3-phase, 11kV, distribution line, having a line impedance of 0.4+j0.3 Ω. A current of 2000A flows during peak load and a minimum possible current of 800A flows during low load period.

i. Calculate the maximum and minimum phase voltage magnitude drops in the line.

ii. Determine the possible angular displacement of the rotor required to keep voltage magnitudes at 11kV on both side of IVR

iii. Show with the aid of a 3 phase phasor diagram the voltage magnitudes and angles on both ends of the line with IVR connected.

(12 Marks)

Question FOUR

a)

i. Explain with the aid of sketches the operation of switched reluctance synchronous machine

ii. State any FOUR advantages of the motor above over permanent magnet counterpart

(11 Marks)

b) A permanent magnet stepper motor is required to rotate a 21cm diameter robot wheel through a 20m distance in 10 seconds. If the stator and rotor poles are 12 and 10 respectively. Determine

i. Resolution

ii. Drive frequency assuming it was a 6 phase machine

(9 Marks)

Question FIVE

a)

i. Explain with the aid of a sketch how a Linear Induction Motor(LIM) operates.

ii. Highlight the application and the limitations of the motor above.

iii. State why all LIM's are typically polyphaser machines.

(11 Marks)

b)

i. Calculate the linear speed of ferromagnetic material moved by a 12 pole, 50Hz, 1.2m long LIM operating with 7% slip.

ii. A equivalent rotary machine is applied for the same function with a conveyer belt system. Estimate the rotor radius of the new machine

iii. Given that LIM constants R_1 and X_{11} for a 3-phase 415V machine above are 9.8 and 6.7 respectively, assuming 90% determine the linear force output.

(9 Marks)