MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

FIFTH YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EES 146: ELECTRICAL MACHINE DRIVE

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer Question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) Define the following terms

   i. Electrical machine drive (2marks)

   ii. Permanent-magnet sysnchronous motor (2marks)

   iii. Open-loop transfer function of a dc motor drive (2marks)

b) Briefly outline the functional parts of an electrical drive system. (4marks)

c) A 400v,60Hz, 4-poles, star connected inductin motor has its rotor running at a speed of 1750rpm. Determine

   i. Synchronous speed (3marks)

   ii. Slip (1mark)

d) i. Determine the value of VR in fig 1.

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   ii.With the aid of an output waveforms, explain the operation of a three phase fully controlled converter. (4marks)

e) A15hp,220v,200r.p.m. separately excited dc motor controls a load requiring a torque of 43 N-M at a speed of 1200r.p.m. The field circuit resistance Rf = 147$\boldsymbol{\Omega}$, the armature circuit resistance Ra = 0.25$\boldsymbol{\Omega}$ and the voltage constant of the motor Kv=0.7032. The field voltage Vf=220V. the viscous friction and no load losses are negligible. The armature current may be assumed continuous and ripple free. Determine

   i. Back e.m.f. (2marks)

   ii. Required armature voltage (2marks)

f) With the aid of an output waveform, explain the operation of a tachogenerator in machine drive speed control. (4marks)

g) Using a block diagram, explain closed loop control of inductin motors by ac voltage controllers at a fixed frequency (3marks)

SECTION TWO: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

a) A single phase ac input voltage is controlled by one silicon controlled rectifier (SCR) fired at 75^{o} firing angle to power adc motor to drive a hoist machine
   i. Define firing angle (2marks)
   ii. Draw and discuss the dc output waveform of the system (5marks)

b) Using a circuit diagram, explain the operation of a two-quadrant dc chopper drive as applied to a separately excited dc motor. (7marks)

c) Explain any three functional parts of a microprocessor control system drives (6marks)

QUESTION THREE (20 MARKS)

a) With the aid of circuit diagram explain electronic speed control of a three phase synchronous motor by current-fed Dc link method. (8marks)

b) A three phase 430v, 50Hz, 4-pole star connected reluctance motor has Xd=8$\boldsymbol{\Omega}$,Xq -2$\boldsymbol{\Omega}$ and negligible armature resistance for a load torque of 80N-m, neglecting rotational losses calculate the
   i. Load angle (4marks)
   ii. Line current (3marks)
   iii. Input power factor (2marks)

c) Outline the advantages of using a constant voltage Dc link converter in ac synchronous speed control. (3marks)

QUESTION FOUR (20 MARKS)

a) State three advantages of DC machine variable speed drives in electric traction. (3marks)

b) Explain the characteristic curves of armature current, field and armature voltage against the speed when the speed of a separately excited dc motor is varied below and above the base speed indicating the region of constant torque drive and constant power drive regions. (7marks)

c) The speed of a separately excited dc motor is controlled by a single-phase semiconverter. The field current which is also controlled by a semiconductor is set to the maximum possible value. The ac supply voltage to the armature and field converters is single-phase, 230v, 60Hz. The armature resistance Ra=0.25$\boldsymbol{\Omega}$, the field resistance Rf=147$\boldsymbol{\Omega}$ and the

motor voltage constant Kv=0.7032. The load torque Tl=43N – m at 1000r.p.m. The viscous friction and no-load losses are negligible. Assuming a ripple free armature and field currents.

Determine the

i. Field current (5marks)

ii. Delay angle of the converter in the armature circuit (5marks)