



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: NOVEMBER 2024

TIME: 2 HOURS

DATE: Pick Date Select Month Pick 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 30Marks. Each of other question carries 20 marks. Attempt any **THREE** Questions.

Do not write on the question paper.

Question ONE(Compulsory)

- a) State FIVE
- Advantages of Variable Reluctance aover Permanent Magnet micromachines.
 - Five possible types of stepper motors.

(10 Marks)

- b) Five possible types of stepper motors
- Sketch a diagram of a servomechanism.
 - Explain the various parts of the servomechanism in (i) above.

(8 Marks)

- c) A DC servomotor has a torque constant of 0.075 N-m/A and a voltage constant of 0.12 V/(rad/sec) . The armature resistance is 2.5 Ohm . A terminal voltage of 24V is used to operate the motor. Determine:
- The starting torque generated by the motor just as the voltage is applied.
 - The maximum speed at a torque of zero.
 - The operating point of the motor when it is connected to a load whose torque characteristic is proportional to the speed with a constant of proportionality = $0.0125 \text{ N-m/(rad/sec)}$.

(12 Marks)

Question TWO

- a)
- With the aid of a diagram describe the construction of hybrid stepper motor.
 - State TWO advantages and TWO disadvantages of hybrid stepper motors.
- b) A reluctance type mini-synchronous machine system is required to move at a speed of 1.2 m/s with the radius of the wheel is 0.05 m . The mass of your system is 10 kg , and is to accelerate at 2 m/s^2 . Take the friction coefficient as 0.6 and calculate:
- The maximum(no load) velocity of the system
 - The value of the torque requirement
 - Extra torque when scaling 10° inclines
 - Traction limited torque(slip torque)
 - Power

(12 Marks)

Question THREE

- a) Sketch circuit diagrams for the following special DC machines
- Universal Motor
 - Rosenberg Generator
 - Rototrol
 - Regulex
 - Metadyne
- b) Given a standard 3390HZ to obtain a 1800 RPM speed measurement for the Tachometer Fig Q3 Below: Position Seings are as follows: Position 1: $0.26 - 0.72 \text{ sec}$; Position 2: $0.72 - 1.43 \text{ sec}$; Position 3: $1.43 - 2.85 \text{ sec}$ and Position 4: $2.85 - 5.7 \text{ sec}$.

(10 Marks)

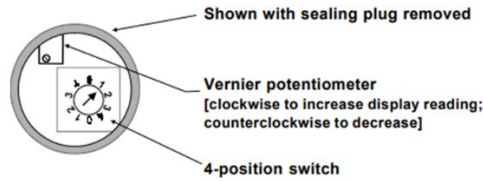


Fig. Q3

- i. State the step in adjusting(calibrating) the Tachometer
- ii. Calculate the number of teeth in Tachometer
- iii. Calculate Gate Time
- iv. Select the position for Gate Time
- v. Determine possible Pulse Rate Multiplication

(10 Marks)

Question FOUR

- a)
 - i. Explain the principle applied in torque transmitters.
 - ii. State any TWO advantages and TWO disadvantages of applying resolvers over digital mathematical processor blocks.

(8 Marks)

- b) A resolver has a sinusoidal input input voltage of maximum voltage of 79V calculate the output voltage corresponding to angular shift of 30°

(4 Marks)

- c) A a Synchro Receiver is shown in **Fig. Q4** below. The received voltage is 84V

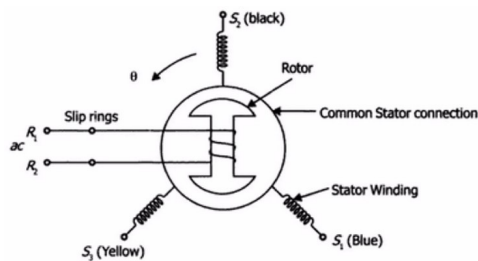


Fig Q4

Calculate the output 3 phase voltages voltages.

(8 Marks)

Question FIVE

- a)
 - i. Sketch the a block diagram showing closed loop control of a stepper motor.

ii. Explain the operation of the circuit in (i) above.

(8 Marks)

b) A stepper motor has a step angle of 1.8° and is driven at 4000pps. Determine:

i. The resolution of the stepper motor is 200 steps/rev.

ii. The motor speed is 1200rpm.

iii. The number of pulses required to rotate the shaft through 54° is 30

(12 Marks)