



# **MURANG'A UNIVERSITY OF TECHNOLOGY**

## **SCHOOL OF ENGINEERING AND TECHNOLOGY**

### **DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

**UNIVERSITY ORDINARY EXAMINATION**

**2023/2024 ACADEMIC YEAR**

**FOURTH YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR  
OF TECHNOLOGY IN MECHANICAL ENGINEERING**

**EET 216: ELECTRICAL MACHINES**

**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) State two advantages of three phase transformers over single phase transformers (2marks)
- b) A transformer has 600 primary turns and 150 secondary turns. The primary and secondary resistances are  $0.25\ \Omega$  and  $0.01\ \Omega$  respectively and corresponding leakage reactances are  $1.0\ \Omega$  and  $0.04\ \Omega$  respectively. (7marks)

Determine

- i) The equivalent resistance referred to the primary winding
  - ii) The equivalent reactance referred to the primary winding
  - iii) The equivalent impedance referred to the primary winding
  - iv) The phase angle of the impedance
- c) Give two advantages of three-phase squirrel cage induction motors over slip-ring induction motor. (2marks)
- d) A 440V, 60Hz, six-pole, 3 $\phi$  induction machine is taking 50kVA at 0.8 power factor and is running at a slip of 2.5. The stator copper losses are 0.5kW and rotational losses are 2.5kW. Compute: (5marks)
- i) The total copper loss
  - ii) The shaft HP
  - iii) The efficiency
  - iv) The shaft torque
- e) A series motor has an armature resistance of  $0.2\ \Omega$  and a series field resistance of  $0.3\ \Omega$ . It is connected to a 240V supply and at a particular load runs at 24 rev/s when drawing 15A from the supply. (6marks)
- i. Determine the generated e.m.f. at this load.
  - ii. Calculate the speed of the motor when the load is changed such that the current is increased to 30A. Assume that this causes a doubling of the flux.
  - iii. Sketch and explain the speed/current characteristic curve for the motor.
- f) A shunt generator supplies a 20kW load at 200V through cables of resistance,  $R=100\text{m}\ \Omega$ , as shown in fig QH. If the field winding resistance,  $R_1=50\ \Omega$  and the armature resistance,



- iii. The output power of the motor if friction and windage losses are 710w and
  - iv. The efficiency of the motor, neglecting rotor iron loss.
- d) A 500V shunt motor runs at its normal speed of 10 rals when the amature current is 210A. The armature resistance is 0.2\_\_\_\_\_
- i. Determine the speed when the current is 60A and resistance of 0.5\_\_\_ is connected in series with the amature, the shunt field remaining constant.
  - ii. Determine the speed when the current is 60A and the shunt field is reduced to 80% of its normal value by increasing resistance in the field circuit.

**QUESTION FOUR (20 MARKS)**

- a) Explain the principle of operation of a transformer (6marks)
- b) A 500V shunt motor runs at its normal speed of 10 revls when the armature current is 120A. The amature resistance is 0.2 \_\_\_\_\_. Determine the speed when the current is 60A and a resistance of 0.5\_\_\_ is connected in series with the armature, the shunt field remaining constant. (4marks)
- c) A 400kVA transformer has a primary winding resistance of 0.5\_\_\_ and a secondary winding resistance of 0.00l\_\_\_\_\_. The iron loss is 2.5kW and the primary and secondary voltages are 5kV and 320v respectively of the transformer (a) on full load, and (b) on half load. Determine also the maximum efficiency for this transformer assuming the power factor remains unchanged. (10marks)