TEVETA

Technical Education, Vocational and Entrepreneurship Training Authority

DIPLOMA IN BIOMEDICAL ENGINEERING

LEVEL 6 YEAR II EXAMINATIONS

FINAL INTEGRATED SUMMATIVE EXAMINATIONS

SITTING: JULY/AUGUST 2025

SUBJECT: ELECTRICAL TECHNOLOGY II

TIME: THREE (3) HOURS **TOTAL MARKS: 100**

PASS MARK: 50

INSTRUCTIONS TO CANDIDATE

1. Write your Examination number and National Registration Card (NRC) number on the answer booklet provided. Ensure you append your signature in the space provided on the answer booklet.
2. Write the ANSWER SCRIPT SERIAL NUMBER on the examination register and on the entry slip.
3. There are EIGHT (8) questions in this paper. Answer FIVE (5) questions.
4. Diagrams may be used where necessary to clarify your answer.
5. Cell phones and programmable calculators are not allowed in the examination room.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

QUESTION 1

a) With the aid of sketches, explain the principle of operation of a cage induction motor. [8 marks]

b) A four-pole cage induction motor is run from a 50 Hz supply and has a slip of 4%. The rotor shaft drives a pulley wheel 400 mm in diameter, which has a tangential force of 250 N exerted upon it. Calculate the power output from the rotor in watts. [6 marks]

c) Calculate the torque developed by a 22 kW four-pole induction motor run at 5% slip from a 380 V, 50 Hz supply [6 marks]

[TOTAL MARKS 20]

QUESTION 2

a) Explain the following types of transformers:
   i) Current transformers. [2 marks]
   ii) Voltage transformers. [2 marks]

b) State **four (4):**
   i) Reasons transformers may be operated in parallel. [4 marks]
   ii) Condition that should be met when transformers are operated in parallel. [4 marks]
   iii) Advantages of operating transformer in parallel. [4 marks]
   iv) Disadvantages of operating transformers in parallel. [4 marks]

[TOTAL MARKS 20]

QUESTION 3

A long shunt compound generator delivers a current to a 10 Ω load at 200 V. The armature, series field and shunt field resistances are 0.05 Ω, 0.03 Ω and 250 Ω respectively. The generator uses carbon brushes which offer appreciable resistance in the armature circuit. Calculate the:

a) Load current [4 marks]

b) Shunt field current [4 marks]

c) Armature current [4 marks]

d) Generated e.m.f. [8 marks]

[TOTAL MARKS 20]

QUESTION 4

a) Explain reasons single phase a.c motors are not self-starting. [3 marks]

b) State **three (3)** methods of starting single phase motors. [3 marks]

c) With the aid of diagrams describe the principle of flux rotation in 3-phase a.c machines. [6 marks]

d) With the aid of diagrams, explain how a wound rotor 3-phase motor may be started. [8 marks]

[TOTAL MARKS 20]

QUESTION 5

a) Derive from first principles an expression for the e.m.f. of a d.c. generator. [12 marks]
b) Calculate the e.m.f. developed in the armature of a two-pole d.c. generator, whose armature has 280 conductors and is rotating at 100 rpm. The flux per pole is 0.03 wb. [8 marks]

[TOTAL MARKS 20]

QUESTION 6

A 37.3 kW, 4-pole, 380 V, 50 Hz induction motor has a friction and windage torque of 22 Nm. The stator losses equal the rotor circuit loss. Given that the motor is running at 1, 440 rpm, compute the following:

a) Synchronous speed [3 marks]
b) Percentage slip [3 marks]
c) Gross mechanical power [4 marks]
d) The input stator power, when delivering full-load output at a speed of 1,440 rpm. [10 Marks]

[TOTAL MARKS 20]

QUESTION 7

The open circuit and short circuit tests on the **8 kVA, 220/110 V** transformer yielded the following results:

O.C Test: P_{oc} = 116 W I_{oc} = 1.65 A V_{oc} = 210 V (on primary – secondary opened)
S.C Test: P_{sc} = 172 W I_{sc} = 28 A V_{sc} = 12 V (on primary – secondary shorted)

a) State the values of the core and copper losses [2 marks]
b) Calculate the:
   i) Equivalent primary phase angle Φ_e [2 marks]
   ii) No load phase angle Φ_o [2 marks]
   iii) Working current component (I_w) [2 marks]
   iv) Magnetizing current component (I_m) [2 marks]
   v) Transformer efficiency on full load at a power factor of 0.76 lagging [6 marks]
   vi) Percentage (%) voltage regulation and the secondary voltage [4 marks]

[TOTAL MARKS 20]

QUESTION 8

A 240 V, 6 pole series wound DC motor with 960 wave wound armature conductors. The motor is driving an 8.2 kW mechanical load and it is drawing 50 A from the supply. The motor has 30 mwb of flux per pole and its armature circuit resistance is 0.6 Ω.

Calculate the:

a) Gross armature torque [5 marks]
b) Shaft torque [5 marks]
c) Lost torque due to friction. [5 marks]
d) Windage and iron losses in the motor. [5 marks]

[TOTAL MARKS 20]