

PP1



TECHNICAL UNIVERSITY OF MOMBASA

**SCHOOL OF ENGINEERING AND TECHNOLOGY
ELECTRICAL AND ELECTRONICS ENGINEERING**

UNIVERSITY EXAMINATION FOR:

DEGREE

EEE 4505: ELECTRICAL MACHINE DESIGN

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2024

TIME: 2 HOURS

DATE:

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Attempt Question 1, Compulsory and any other Two Questions.

Do not write on the question paper.

Question ONE

- a) Explain the three (3) design features of power and distribution transformers

[6 MARKS]

- b) Derive the volt/ turn equation of a single phase transformer

[7 MARKS]

- c) Show that the rating of an electrical machine is proportional to the specific magnetic loading, specific electric loading dimensions of the machine and the speed of the machine.

[6 MARKS]

- d) A three phase 200kW, 3.3kV, 50Hz, 4 pole induction motor has the following dimensions. Internal diameter of the stator =56.2cm, outside diameter of the stator=83cm, length of stator 30.5cm, number of stator slots=60, width of stator slot=1.47cm, depth of stator slot =4.3cm, radial gap=0.16cm, number of rotor slots=0.95cm. Assuming an airgap flux density of 0.5T, calculate flux density in
- [11 MARKS]**
- i. Stator teeth
 - ii. Stator core

Question TWO

- a) Using a well labelled diagram explain the principle of temperature rise due to thermal action **[4 MARKS]**
- b) List and explain three (3) advantages of using silicon steel for insulation in electric machines **[3 MARKS]**
- c) Using a well labelled diagram and appropriate equations derive the output equation of DC machine **[3 MARKS]**
- d) A 15kW, 440v, 4 pole, 50Hz, 3 phase induction motor is built with a stator bore of 0.25m and a core length of 0.16m. the specific electric loading is 2300ac/m. using data of this machine determine the core dimensions , number of slots and number of stator conductors for a 11kW,460V ,6 pole 50HZ motor. Assume full load efficiency of 84% and power factor of 0.82. The winding factor is 0.955 **[10 MARKS]**

Question THREE

- a) Explain five (5) types of cooling systems **[5 MARKS]**
- b) Show that for a fan supplying air flow at a pressure p, N/m² with an efficiency of η , the power required to provide this quantity of air is given by Equation below **[5 MARKS]**

$$P_{fan} = \frac{pQ}{\eta \cdot 10^3} kW$$

- c) Estimate the volume of cooling air required for an alternator in cubic metre per second with minimum temperature rise of 40°C from the following given data: Total weight of active iron=1500kg, Watt loss iron=8 watt, Total weight of active

copper=700kg, Watt loss in copper=20 watts/kg, Stray losses=20% of total losses (copper and iron), Inlet temperature of air=25°C, Barometric height in mm of mercury=780

[10 MARKS]

Question FOUR

- a) List and explain six (6) factors considered in the design of electrical of machine and apparatus **[6 MARKS]**
- b) Name and explain six (6) types of enclosure for rotating electrical machines **[4 MARKS]**
- c) A 750kVA, 6600/415V, 50HZ, 3 phase, Delta-star connected, core type transformer has the following Data. Width of LV winding =3cm, width of HV winding =2.5cm, width of duct and insulation between LV and HV=1.0 cm, height of windings=40cm, length of mean turn=150cm, volt/turn=10v. Estimate the per unit regulation at 0.8 pf lagging, if maximum efficiency of transformer is 98% and occurs at 85% of full load. **[10 MARKS]**

Question FIVE

- a) Derive the output equation of an induction motor **[6 MARKS]**
- b) Find the main dimensions D and L of a three phase induction machine with the following data: 20hP, 415V, 50Hz,4 pole, efficiency of 85%,power factor of 0.85 lagging and a winding factor of 0.95 **[5 MARKS]**
- c) A 250kW, 500V, 6 pole,600rpm DC generator is built with an armature of 0.75m and core length of 0.3m. The lap connected armature has 720 conductors. Using data obtained from this machine, determine the armature diameter, core length, number of armature slots, armature segments for a 350kW, 440V, 720RPM, 6 pole DC generator. **[9 MARKS]**