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UNIVERSITY EXAMINATIONS 2024/2025

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING
AND
FOURTH YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF EDUCATION TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

EET 3309: ELECTRICAL MACHINES II

DATE: JANUARY 2025   TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Draw and explain the basic operation of a transformer.   (5 Marks)

b) Explain the advantages of using transformers in AC power distribution.   (3 Marks)

c) Describe the voltage transformation ratio in a transformer.   (4 Marks)

d) Explain why a three-phase transformer generally preferred over a bank of single-phase transformers.   (2 Marks)

e) Describe the types of three-phase transformer winding connections.   (4 Marks)

f) A 2000/200V 20 kVA transformer has 66 turns in the secondary. Neglecting the losses, calculate: (4 Marks)

     i. The number of primary turns

     ii. The primary and secondary full load currents.

g) What is the significance of transformer vector groupings? (3 Marks)

h) Explain how harmonics affect the performance of a three-phase transformer. (5 Marks)

QUESTION TWO (15 MARKS)

a) Describe the methods of speed control in three-phase induction motors. (3 Marks)

b) Explain the two ways a three-phase transformer can be constructed. (2 Marks)

c) A 2MVA transformer (A) is connected in parallel with a 4MVA transformer (B) to supply a 3 phase load of 5000kVA at 0.8 p.f. lagging. Determine the kVA supplied by each transformer assuming equal no-load voltages. The % voltage drops in the windings at their rated loads are as follows:

Transformer A: resistance 2%   reactance 8%

Transformer B: resistance1.6%   reactance 3%   (10 Marks)

QUESTION THREE (15 MARKS)

a) List at least four applications of three-phase transformers. (4 Marks)

b) Explain how harmonics affect the performance of a three-phase transformer. (5 Marks)

c) A 100 kVA, 11/0.44 kV, 50 Hz single-phase transformer has an effective core cross-sectional area of 0.02 m² and 100 turns in the low-voltage (LV) winding. Determine: (6 Marks)

    i. The maximum value of flux density

    ii. The number of turns on the high-voltage (HV) winding

    iii. The full load current in each winding.

QUESTION FOUR (15 MARKS)

a) Explain the basic principle of operation of a three-phase induction motor. (4 Marks)

b) List the Conditions for parallel operation of transformers. (5 Marks)

c) A 400 V, 50 Hz, 4-pole, three-phase induction motor is running at 1440 RPM. Calculate:

(6 Marks)

    i.   The synchronous speed

   ii.   The slip

  iii.   The rotor frequency

QUESTION FIVE (15 MARKS)

a) A three-phase induction motor has a slip of 10% when running at full load. If the motor's synchronous speed is 600 RPM, calculate the full-load rotor speed. (5 Marks)

b) Describe the different methods of braking used in three-phase induction motors.

(6 Marks)

c) A 5 HP, 400 V, three-phase induction motor has a full-load efficiency of 85% and a power factor of 0.88. Calculate the full-load line current. (4 Marks)