



MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 300: ELECTRICAL MACHINES II

DATE:

TIME:

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**. Attempt any other **two** questions.

Do not write on the question paper.

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Explain the main reason why single phase induction motors are not self-starting.
(3 marks)
- b) A 250watts, 230 volts, 50 hertz capacitor start motor has the following constants for the main and auxiliary windings:
Main winding; $Z_m = (4.5 + j3.7)$ ohms
Auxiliary winding $Z_s = (9.5 + j3.5)$ ohms.
Determine the value of the starting capacitor that will place the main and auxiliary winding currents in quadrature.
(7 marks)
- c) A three phase step down transformer is connected to 6.6kv mains and takes 10A. If the transformation ratio is 12, neglecting losses, determine the output line voltage and line current for the following connections;
(i) Δ/Δ
(ii) Δ/Y
(iii) Y/Δ
(6 marks)

- d) Draw a schematic rotor circuit diagram of a three phase wound rotor type motor and its torque –rotor resistance characteristic curve used in demonstrating speed control. (6 marks)
- e) Show that the maximum starting torque of a three phase squirrel cage induction motor is given by:

$$T_{s(max)} = \frac{K}{2R_2} \quad \text{where } K = \text{motor constant and } R_2 = \text{rotor resistance.} \quad (8 \text{ marks})$$

QUESTION TWO (20 MARKS)

- a) Draw a line diagram of Star-delta method of starting a three phase squirrel cage induction motor. (4 marks)
- b) A 460 volts, 25hp, 60hertz, four pole star connected three phase induction motor has the following impedances;
 $R_1 = 0.641\Omega$, $R_2 = 0.332\Omega$, $X_1 = 1.106\Omega$, $X_2 = 0.464\Omega$ and $X_m = 26.3\Omega$. The mechanical loss is 100 watts and core loss is 1000watts for a slip of 2.2%. Determine:
 (i) The speed of the motor
 (ii) The stator current
 (iii) The power factor
 (iv) The developed power
 (v) The output power
 (vi) The developed torque
 (vii) The output torque
 (viii) The efficiency of the motor. (16 marks)

QUESTION THREE (20 MARKS)

- a) With an aid of a circuit diagram of two single phase transformers with un equal voltage ratios sharing a load, derive the formula of the current circulating in their secondary windings. (12 marks)
- b) A 500KVA single phase transformer has 0.01 p.u resistance, 0.05 p.u reactance and open circuit secondary voltage of 405volts. It is connected in parallel with a 250KVA single phase transformer having 0.015 p.u resistance, 0.04 p.u reactance and open circuit secondary voltage of 415 volts. Determine:
 (i) Circulating current at no-load
 (ii) Current delivered by the secondary of each transformer to a load of 750 KVA at 0.8 lagging power factor. Take voltage across load to be 400 volts. (8 marks)

QUESTION FOUR (20 MARKS)

- a) With an aid of a diagram, describe the principle of operation of a single phase shaded pole motor. (6mks)
- b) Determine the mechanical power output of 185 watts, 4-pole, 110 volts, 50 hertz single phase induction motor whose constatnts at 5% slip are:
 $R_1 = 1.861\Omega$, $R_2 = 3.56\Omega$, $X_1 = 2.56\Omega$, $X_2 = 2.56\Omega$ and $X = 53.5\Omega$.
Core loss is 3.5 watts, frictional and windage loss is 13.5 watts. (9mks)
- c) A current transformer has turns ratio of 1:399 and is rated as 2000/5A. the core loss component is 3A and magnetizing component is 8A, under full load conditions. Given that the secondary circuit power factor is 0.8 leading, determine;
(i) Phase angle
(ii) Ratio error under full load condition. (5mks)

QUESTION FIVE (20 MARKS)

- a) A 746kw, three phase, 50hertz, 16-pole induction motor has a rotor impedance of $(0.02 + j0.15)\Omega$ at stand still. Full load torque is obtained at 360 rpm. Determine:
(i) The ratio of maximum to full load torque
(ii) The speed at maximum torque
(iii) The rotor resistance to be added to get the maximum torque. (9mks)
- b) Outline four conditions to be met before parallel connection of transformers. (4mks)
- c) With an aid of a diagram, describe short circuit test of a three phase transformer. (7mks)