MACHAKOS UNIVERSITY COLLEGE

SECOND SEMESTER EXAMINATION 2018/2019

THIDR YEAR SUPPLEMENTARY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 300 ELECTRICAL MACHINES II

DATE: 27TH APRIL, 2019 **TIME: 8.00 A.M - 10.00 A.M**

INSTRUCTIONS

This paper consists of **FIVE** questions.

Answer **QUESTION 1** and ANY **OTHER TWO** questions.

Question 1 carries 30 marks and is COMPULSORY.

1. (a) A 3-phase, 6,600/415-V, 2,000-kVA, transformer has a per unit resistance of 0.02 and a per unit leakage reactance of 0.1. Calculate the Cu loss and regulation at full-load 0.8 p.f. lag.

(6 marks)

(b) A 3-∅ induction motor is wound for 4 poles and is supplied from 50-Hz system. Calculate:

(i) the synchronous speed
(ii) the rotor speed, when slip is 4% and
(iii)Rotor frequency when the rotor runs at 600 rpm.

(6 marks)

(c) A 4-pole, 3-phase squirrel-cage induction motor operates from a supply whose frequency is 50Hz. Calculate the:

(i) speed at which the magnetic field of the stator is revolving
(ii) speed of the rotor when the slip is 0.04
(iii) frequency of the rotor currents when the slip is 0.03
(iv) frequency of the rotor currents at standstill

(6 marks)

(d) Calculate the mechanical power output of a 185W, 4-pole, 110V, 50Hz single-phase induction motor, whose constants are given below at a slip of 0.05: $R_1 = 1.86\Omega$, $X_1 = 2.56\Omega$, $X_\phi = 53.5\Omega$, $R_2 = 3.56\Omega$, $X_2 = 2.56\Omega$, Core loss $= 3.5$W, Friction and windage loss $= 13.5$W.

(6 marks)

(e) Calculate the steps in a 5-step rotor resistance starter for a 3-phase induction motor. The slip at the maximum starting current is 2% with slip-ring short-circuited and the resistance per rotor phase is 0.02Ω.

(6 marks)

2. (a) With the aid of suitable diagram, discuss the Scott or T-T connection of a transformer.

(15 marks)

(b) A Δ-Δ bank consisting of three 20kVA, 2300/230-V transformers supplies a load of 40 kVA. If one transformer is removed, calculate for the resulting V-V connection :

(i) kVA load carried by each transformer
(ii) percent of rated load carried by each transformer
(iii) total kVA rating of the V-V bank
(iv) ratio of the V-V bank to Δ-Δ bank transformer ratings
(v) percent increase in load on each transformer when bank is converted into V-V bank.

(5 marks)

3. (a) With the aid of suitable diagrams, describe how a single-phase split-phase induction motor is made self-starting.

(10 marks)

(b) A universal series motor has a resistance of 30Ω and an inductance of 0.5 H. When connected to a 250 V d.c. supply and loaded to take 0.8 A, it runs at 2,000 r.p.m. Estimate its speed and power factor, when connected to a 250-V, 50-Hz a.c. supply and loaded to take the same current.

(10 marks)

4. (a) With the aid of suitable diagrams and waveforms, describe how a rotating magnetic field is produced in a three-phase induction motor.

(13 marks)

(b) A 110-V, 3-∅, star-connected induction motor takes 25 A at a line voltage of 30 V with rotor locked. With this line voltage, power input to the motor is 440 W and core loss is 40 W. The d.c. resistance between a pair of stator terminals is 0.1 Ω. If the ratio of a.c. to d.c. resistance is 1.6, calculate the equivalent leakage reactance/phase of the motor and the stator and rotor resistance per phase.

(7 marks)

5. (a) With the aid of suitable diagrams, describe speed control of an induction motor by injection of an e.m.f. in the rotor.

(10 marks)

(b) Draw the circle diagram for a 3.73 kW, 200-V, 50-Hz, 4-pole, 3-∅, star-connected induction motor from the following test data:

No-load : Line voltage 200 V, line current 5 A; total input 350 W

Blocked rotor : Line voltage 100 V, line current 26 A; total input 1,700 W

Estimate from the diagram for full-load condition, the line current, power factor and also the maximum torque in terms of the full-load torque.

The rotor Cu loss at standstill is half the total Cu loss.

(10 marks)