

**FINAL
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : January 2022

Programme : Diploma in Mechanical Engineering (DMEN)

Course : EEE2115: Electrical Power & Machines

Date of Examination : 5 March 2022 (Saturday)

Time : 4.00pm – 6.30pm Reading Time : Nil

Duration : 2 Hours 30 Minutes

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions. All questions carry equal marks.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Nil

Examiner(s) : Richard Lai

Chief Moderator : Dennis Koh

This paper consists of 5 printed pages, including the cover page

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DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EEE2115: ELECTRICAL POWER & MACHINES
FINAL ALTERNATIVE ASSESSMENT: JANUARY 2022 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions. All questions carry equal marks.

Question 1

- (a) A 3 phase, 208 V induction motor having a synchronous speed of 1200 r/min runs at 1140 r/min when connected to a 215 V line and driving a constant torque speed load. Find the speed if the voltage increases to 240 V. (7 marks)
- (b) A 208 V, 10 hp, four pole, 60 Hz, Y-connected induction motor has a full load slip of 5 percent. Find
- (i) synchronous speed of this motor, (2 marks)
 - (ii) rotor speed of the motor, (2 marks)
 - (iii) rotor frequency, (2 marks)
 - (iv) the shaft torque in Newton-meter. (2 marks)
- (c) A 480 V, 60 Hz, 50 hp, three phase induction motor is drawing 60 A at 0.85 power factor lagging. The stator copper losses are 2 kW and the rotor copper losses are 700 W. The friction and windage losses are 600 W, the core losses are 1800 W and the stray losses are negligible. Find
- (i) the air gap power, (4 marks)
 - (ii) the power converted, (2 marks)
 - (iii) the output power, (2 marks)
 - (iv) the efficiency of the motor. (2 marks)

Question 2

- (a) A 460 V, 25 hp, 60 Hz, four pole, Y-connected induction motor has the following impedances in Ohms per phase referred to the stator circuit:

$$\begin{aligned} R_1 &= 0.641 \, \Omega & R_2 &= 0.332 \, \Omega \\ X_1 &= 1.106 \, \Omega & X_2 &= 0.464 \, \Omega & X_M &= 26.3 \, \Omega \end{aligned}$$

The total rotational losses are 1100 W and are assumed to be constant. The core loss is lumped in with the rotational losses. For a rotor slip of 2.2 percent at the rated voltage and rated frequency, find the motor's

- (i) rotor's mechanical shaft speed, (3 marks)
(ii) stator current. (6 marks)

- (b) A 208 V, 45 kVA, 0.8 power factor lagging, Δ -connected, 60 Hz synchronous machine has a synchronous reactance of 2.5 Ω and a negligible armature resistance. Its friction and windage losses are 1.5 kW and its core losses are 1 kW. Initially, the shaft is supplying a 15 hp load and the motor's power factor is 0.8 leading.

- (i) Sketch the phasor diagram of the motor and find the values of internal generated voltage, the armature current and the load current. (10 marks)
(ii) Assume the shaft load is now increased to 30 hp, sketch the behaviour of the phasor diagram in response to this change. (6 marks)

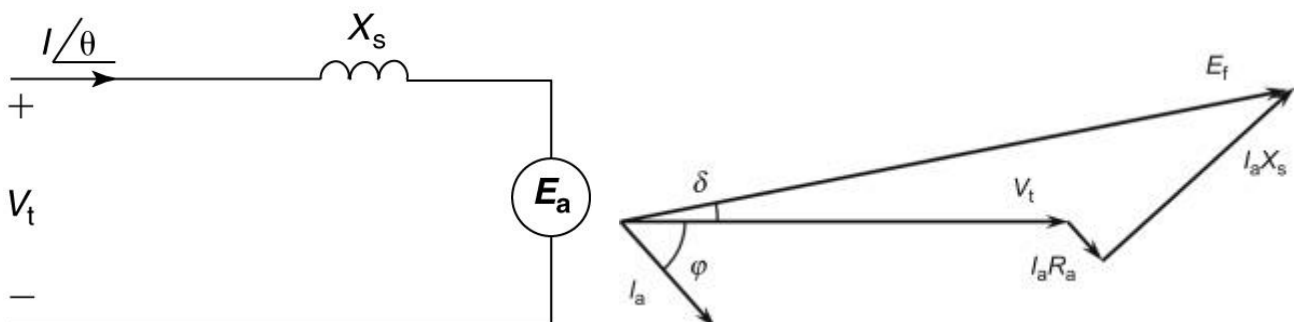
Question 3

- (a) The frequency and induced voltage in the rotor of a certain 6 pole wound rotor induction motor, whose shaft is blocked, are 60 Hz and 100 V respectively. Find the corresponding values when the rotor is running at 1100 r/min. (4 marks)

- (b) A certain 3 phase, 460 V, two-pole, 60 Hz, wye-connected synchronous alternator, with a synchronous reactance of $1.26 \Omega/\text{phase}$ is connected to an infinite bus. The power angle, when supplying 112 kW to the bus is 25° . Neglecting the loss, find
- (i) turbine torque supplied to the alternator in Nm, (2 marks)
 - (ii) excitation voltage, (3 marks)
 - (iii) active and reactive components of apparent power, (7 marks)
 - (iv) power factor. (1 mark)
- (c) Define the following torques for the synchronous motor.
- (i) Starting torque. (2 marks)
 - (ii) Running torque. (2 marks)
 - (iii) Pull in torque. (2 marks)
 - (iv) Pull out torque. (2 marks)

Question 4

- (a) Figure Q4(a) shows the three phase synchronous motor equivalent circuit diagram and its phasor diagram. Assuming that the motor has terminal voltage of 400 V, with back e.m.f of 100 V operate at 50 Hz, with inductance of 100 mH. Find
- (i) the torque when the power angle, $\delta = 25^\circ$ (6 marks)
 - (ii) the maximum torque. (3 marks)



FigureQ4(a)

- (b) A three phase, 600 MVA generator has a rated terminal voltage of 22 kV. The stator winding is star connected and has a resistance of $0.014 \Omega/\text{phase}$ and a synchronous impedance of $0.16 \Omega/\text{phase}$. Find
- (i) the voltage regulation for load having a power factor of unity, (10 marks)
[Hints: neglect the $0.014 \Omega/\text{phase}$]
- (ii) the voltage regulation for load having 0.8 power factor. (6 marks)

~THE END~

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