



INTI
International College Penang
LAUREATE INTERNATIONAL UNIVERSITIES*

FINAL
Examination Paper

(COVER PAGE)

Session : April 2017

Programme : Diploma In Electrical And Electronic Engineering (DEEI)

Course : EEE 2103: Electrical Machines

Date of Examination : 28 July 2017 (Friday)

Time : 2:00pm – 4:00pm Reading Time : Nil

Duration : 2 Hours

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided :

Nil

Examiner(s) : Shalyn Lim Sheue Hui

Moderator : Dr. Ooi Beng Lee

This paper consists of 7 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2103: ELECTRICAL MACHINES
FINAL EXAMINATION: APRIL 2017 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

- (a) Armature windings can be divided into wave winding and lap winding. With a diagram, describe and differentiate the two groups of windings. (8 marks)
- (b) A d.c. generator running at 30 rev/s generates an e.m.f. of 200V. Determine the increase in the flux per pole required to generate 250V at 20 rev/s in percentage. (5 marks)
- (c) A shunt generator supplies a 20kW load at 200V through cables of resistance, $R=100\text{m}\Omega$. If the field winding resistance, $R_f=50\Omega$ and the armature resistance, $R_a=40\text{m}\Omega$.
- (i) Sketch the generator diagram and determine the terminal voltage (3 marks)
- (ii) Calculate the e.m.f. generated in the armature (3 marks)
- (d) A six-pole lap-wound motor is connected to a 250V d.c. supply. The armature has 500 conductors and a resistance of 1Ω . The flux per pole is 20mWb . Calculate
- (i) the speed (4 marks)
- (ii) the torque developed when the armature current is 40A (2 marks)

Question 2

- (a) Discuss four principle losses of machine. (8 marks)
- (b) A 200V, d.c. shunt-wound motor has an armature resistance of 0.4Ω and at a certain load has an armature current of 30A and runs at 1350 rev/min. If the load on the shaft of the motor is increased so that the armature current increases to 45A, determine the speed of the motor, assuming the flux remains constant. (5 marks)
- (c) A series motor has an armature resistance of 0.2Ω and a series field resistance of 0.3Ω . It is connected to a 240V supply and at a particular load runs at 24 rev/s when drawing 15A from the supply.
- (i) Determine the generated e.m.f. at this load (2 marks)
- (ii) Calculate the speed of the motor when the load is changed such that the current is increased to 30A. Assume that this causes a doubling of the flux. (4 marks)
- (d) A 100V d.c. generator supplies a current of 15A when running at 1500 rev/min. If the torque on the shaft driving the generator is 12 Nm, determine
- (i) the efficiency of the generator. (3 marks)
- (ii) the power loss in the generator. (3 marks)

Question 3

- (a) What is auto transformer? Discuss the advantages and disadvantages of the transformer. (6 marks)
- (b) A 2400V/400V single-phase transformer takes a no-load current of 0.5A and the core loss is 400W. Determine the values of the magnetising and core loss components of the no-load current. Sketch the no-load phasor diagram for the transformer. (6 marks)
- (c) A 4500V/225V, 50 Hz single-phase transformer is to have an approximate e.m.f. per turn of 15V and operate with a maximum flux of 1.4T. Calculate the
- (i) number of primary and secondary turns and (3 marks)
- (ii) cross-sectional area of the core (4 marks)
- (d) A 400 kVA transformer has a primary winding resistance of 0.5Ω and a secondary winding resistance of 0.001Ω . The iron loss is 2.5kW and the primary and secondary voltages are 5 kV and 320V respectively. If the power factor of the load is 0.85, determine the efficiency of the transformer on full load. (6 marks)

Question 4

- (a) Discuss the benefit of choosing induction motor. Distinguish between squirrel-cage and wound-rotor types of motor. (8 marks)
- (b) A 3-phase, 60 Hz induction motor has 2 poles. If the slip is 2 percent at a certain load, determine.
- (i) the synchronous speed (2 marks)
 - (ii) the speed of the rotor (3 marks)
 - (iii) the frequency of the induced e.m.f.'s in the rotor (2 marks)
- (c) A The power supplied to a three-phase induction motor is 32kW and the stator losses are 1200W. If the slip is 5 percent, determine
- (i) the rotor copper loss, (4 marks)
 - (ii) the total mechanical power developed by the rotor (2 marks)
 - (iii) the output power of the motor if friction and windage losses are 750W (2 marks)
 - (iv) the efficiency of the motor, neglecting rotor iron loss (2 marks)

Question 5

- (a) Define the terms of *power-system stability*, *steady-state stability* and *transient stability* in a three-phase synchronous generator. Also differentiate the limits of the stability. (5 marks)
- (b) A 1000-hp, 2300-V, wye-connected, three-phase, 60-Hz, 20-pole synchronous motor, for which cylindrical-rotor theory can be used and all losses can be neglected, has a synchronous reactance of $5.00 \Omega/\text{phase}$. The motor is operated from an infinite bus supplying rated voltage and rated frequency, and its field excitation is adjusted so that the power factor is unity when the shaft load is such as to require an input of 750 kW. Compute the maximum torque that the motor can deliver, given that the shaft load is increased slowly with the field excitation held constant. (8 marks)
- (c) A three-phase, 600 MVA generator has a rated terminal voltage of 22V (line). The stator winding is star-connected and has a resistance of $0.014 \Omega/\text{phase}$ and a synchronous impedance of $0.16 \Omega/\text{phase}$. Calculate the voltage regulation for a load having a power factor of
- (i) unity (6 marks)
- (ii) 0.8 lagging (6 marks)

Question 6

- (a) A single-phase transformer has 1000 turns on the primary and 200 turns on the secondary. The no-load current is 3 A at a power factor 0.2 lagging when the secondary current is 280 A at a power factor of 0.8 lagging. Calculate the primary current and power factor. Assume the voltage drop in the windings to be negligible.

(6 marks)

- (b) A DC machine shown in Figure Q6(b). Describe the function of part A and B.

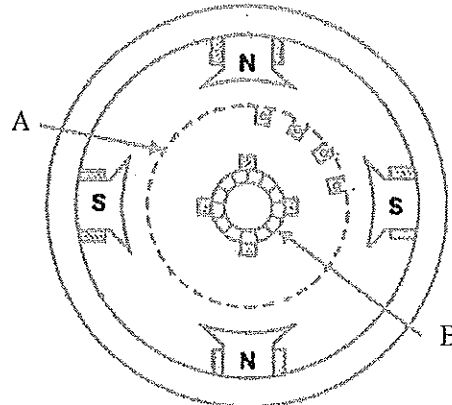


Figure Q6(b)

(3 marks)

- (c) Prove that for a given machine, the torque (T) is proportional to the armature current (I_a) and flux (ϕ)

$$T \propto \phi I_a$$

(5 marks)

- (d) A 415V, three-phase, 50 Hz, 4 pole, star-connected induction motor runs at 24 rev/s on full load. The rotor resistance and reactance perphase are 0.35Ω and 3.5Ω respectively, and the effective rotor-stator turns ratio is 0.85:1. Calculate

- (i) the full load torque

(4 marks)

- (ii) the power output if mechanical losses amount to 770W

(4 marks)

- (iii) the maximum torque

(3 marks)

--THE END--

