INTI
International College Penang
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2016**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE2103: Electrical Machines**
Date of Examination	:	26 July 2016, Tuesday
Time	:	8.00am – 10.00am
Duration	:	2 Hours Reading Time : Nil
Special Instructions	:	

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

IMPORTANT NOTE : **THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL**

Materials Permitted :

Nil

Materials Provided :

Answer Booklet

Examiner(s)	:	**Mr. Alan Wong**
Moderator	:	Mr. Cheah Kean Seng

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

INTI INTERNATIONAL COLLEGE

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2103: ELECTRICAL MACHINES
FINAL EXAMINATION : APRIL 2016 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) Explain the principle of operation of a dc motor. Give an application of each of the three main types of motor (series, shunt and compound). (10 marks)

(b) A shunt generator delivers 195 A at a terminal potential difference of 250 V. The armature resistance and the shunt field resistance are 0.02 Ω and 50 Ω respectively. The iron and friction losses equal 950 W. Find

i. the emf generated (3 marks)

ii. the total copper losses (3 marks)

iii. the output of the prime mover, and (3 marks)

iv. the commercial, electrical and mechanical efficiency. (6 marks)

Question 2

(a) A 10 kVA, single phase transformer is rated at 440 / 220 V. The equivalent resistance is 0.3 Ω and the reactance is 0.42 Ω, both referred to the primary high side. If the transformer is operating at full load condition and 0.4 leading power factor , determine:

i. High side terminal voltage (8 marks)

ii. Voltage regulation (3 marks)

(b) A 60 Hz transformer having a 480 turn primary winding takes 80 W and 1.4 A under no load condition at an input voltage of 120 V. Determine

i. maximum core flux (4 marks)

ii. no-load core-loss equivalent resistance (3 marks)

iii. no-load magnetizing reactance (4 marks)

iv. no-load power factor (3 marks)

Question 3

(a) A DC shunt motor has input voltage 200 V, $R_a = 0.116\ \Omega$ and $R_{shunt} = 75\ \Omega$. It is found that the motor draws a line current of 165.16 A with a shaft speed of 500 rpm. Calculate the output mechanical power.

(7 marks)

(b) A 240V DC separately excited shunt motor has an armature resistance of 0.68 Ω and draws a full current of 24 A at a speed of 100rpm. Calculate :

i. the emf Ea

ii. the output power developed

iii. the torque developed

iv. If the pole flux is reduced by 20%, calculate the new speed.

(10 marks)

(c) A four pole DC motor is wave wound with 540 conductors. The armature current is 60 A and the armature circuit resistance is 0.5 Ω. If the flux per pole is 25 mWb, estimate the speed when the motor run off a 500 V supply.

(8 marks)

Question 4

(a) A 50 kVA, single-phase transformer has 600 turns on primary and 40 turns on secondary. The primary winding is connected to 2.2 kV at 50 Hz supply. Determine:

i. the secondary voltage at no-load

ii. the primary and secondary currents at full-load

iii. Assume a load with power factor of 0.80 , what is the load resistance at the secondary for full load condition. Calculate the active output power at the secondary in this case.

(10 marks)

(b) A 230 / 110V, single phase transformer takes an input of 350VA at no-load, and at rated voltage. The core loss is 110W. Find :

i. no-load power factor

ii. the iron loss component of no-load current

iii. magnetizing component of no-load current

(7 marks)

(c) In a 25 kVA , 2000 / 200 V single-phase transformer, the iron and full load copper losses are 350 W and 400 W respectively, Calculate the efficiency at unity power factor on:

i. full load

ii. 50% full load

(8 marks)

Question 5

A 3-phase , 4000 V ,60 Hz, 5000 hp, 4-pole induction motor is operating at 67% rated load at 4130 V. The breakdown of losses for this load is : stator copper loss =12.4 kW, rotor conductor loss = 9.92 kW, core loss = 12.44 kW, stray power = 10.2 kW, fiction and windage = 18.2 kW.

(a) Sketch the power flow diagram with its values.

(5 marks)

(b) Shaft speed

(7 marks)

(c) Shaft torque

(3 marks)

(d) Developed torque

(4 marks)

(e) Input power to stator

(3 marks)

(f) Overall efficiency

(3 marks)

Question 6

(a) Explain the condition when a synchronous motor operates under normal excitation.

(4 marks)

(b) A 20 kW, 3 –phase, Y-connected , 50 Hz, 400 V, 4-pole synchronous motor is operating at rated condition. It operates with a power angle of 50° and an efficiency of 95 %. The motor has a synchronous reactance of 3 Ω per phase. Determine:

i. the active input power, P_{in}

(4 marks)

ii. the excitation voltage, E_F

(5 marks)

iii. the armature current, I_a

(8 marks)

(c) What is the effect of increasing the field excitation on the performance of a synchronous motor ?

(4 marks)

-THE END-

USEFUL FORMULA

TRANSFORMER

1 horsepower = 746 W

$E_p = 4.44 N_p f \phi_{max}$

$I_o = I_{fe} + I_M$

$$a = \frac{N_{HS}}{N_{LS}} = \frac{V_{HS}}{V_{LS}}$$

$Z_{load,HS} = a^2 . Z_{load,LS}$

$$voltage\_regulation = \frac{E - V_{rated}}{V_{rated}}$$

INDUCTION MOTOR

$$n_s = \frac{120 f_s}{P}$$

$$S = \frac{n_s - n_r}{n_s}$$

$$P_{gap} = \frac{P_{rcl}}{S}$$

$$P_{mech} = P_{gap}(1 - S)$$

$$\eta = \frac{P_{shaft}}{P_{in}}$$

$$F_P = \frac{P_{in}}{S_{in}}$$

SYNCHRONOUS MOTOR

$$V_T = I_a j X_s + E_f$$

$$P_{in,3\phi} = 3 V_T I_a \cos\theta = \frac{-3 V_T . E_f}{X_s} \sin\delta$$

$$P_{losses} = P_{stray} + P_{f,w} + P_{core} + P_{fcl} + P_{scl}$$

DC MACHINE

$$E_a = \frac{nPz\phi_p}{60a} = n\phi_p k$$

$$T_D = B_p I_a k$$

$$R_{acir} = R_a + R_{IP} + R_{CW}$$

$$n = \frac{V_T - I_a R_{acir}}{\phi_p k} where\_\phi_p \neq 0$$

$$P_{mech} = E_a I_a$$

$$T_{D,shunt} \propto I_f I_a$$

$$T_{D,series} \propto I_a^{\,2}$$

$$P_{loss} = P_{acir} + P_b + P_{core} + P_{fcl} + P_{f,w} + P_{stray}$$