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INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session : APR 2013

Programme : DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

Course : EEE 2103 ELECTRICAL MACHINES

Date of Examination : 31 July 2013

Time : 8a.m. – 10a.m. 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) : KEN KONG SENG KUOK

Moderator : ALAN WONG

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

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEE/I)

EEE 2103: ELECTRICAL MACHINES
FINAL EXAMINATION: APR 2013 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) A simple 4 pole shunt DC motor has 4 turns of coil attached between each adjacent commutator bar. The field coil has 20 turns. The reluctance of field coil per turn is found to be 3 mA-t/Wb. The field resistance is 75 Ω . The resistance of the coil attached to the slip ring is 1 Ω . While the motor is powered up with a 10 V DC source, the ammeter shows that the motor is drawing 1 A. What is the speed of rotation? (8 marks)
- (b) A higher angular speed is desired for any practical purposes. To achieve this goal, variable resistors are inserted along the field coil and near the slip ring separately. With proper diagrams, explain the mechanism to change the angular speed by adjusting the variable resistors. (14 marks)
- (c) Left without load, what is the developed torque in N-m with the new speed and resistance setting in part (iii)? (3 marks)

Question 2

- (a) A 1150 – 240 V transformer has a sinusoidal flux expressed by $\Phi = 0.113 \sin 188.5 t$ Wb. Determine the primary and secondary number of turns. (8 marks)
- (b) Data from short-circuit and open-circuit tests of a 25 kVA 6900 – 230 V, 60 Hz transformer are:

Low-side Data	High-side Data
$V_{OC} = 230 \text{ V}$	$V_{SC} = 513 \text{ V}$
$I_{OC} = 5.4 \text{ A}$	$I_{SC} = 3.6 \text{ A}$
$P_{OC} = 260 \text{ W}$	$P_{SC} = 465 \text{ W}$

Determine:

- (i) Magnetizing reactance referred to the high side (5 marks)
- (ii) The per unit parameters (7 marks)
- (iii) Inherent voltage regulation at 0.84 power-factor leading (5 marks)

Question 3

- (a) A 3-phase, 8 poles, induction motor is used to lift an object of 1350 kg to a height of 200 m in 18 s. What is the desired output power from this motor? (3 marks)
- (i) The rotating stator flux is 20 mWb. The frequency of local power supply voltage is 50 Hz. If the induced rotor voltage when the motor is standing still has to be the same as the line voltage, 415V, how many turns should there be for the winding on the rotor bar? (2 marks)
- (ii) The rotor has resistance of 1 Ω . The motor is operating at 0.95 power factor lagging. Determine the value of brake rotor leakage reactance. (2 marks)
- (iii) The motor has 8 stator poles. Find the synchronous speed, n_s . From the value of rotor resistance, R_r , induced rotor voltage, E_{BR} , synchronous speed, n_s , and brake rotor leakage reactance, X_{BR} , determine the starting torque of the motor. (Note: $s = 1$ during start.) (5 marks)
- (iv) The shaft is coupled to a pulley that is 30 cm in diameter, pulling the rope tied to the object. Assuming the motor speed is constant in lifting the object, what is the slip when the motor is in motion? (4 marks)
- (v) Given the rotational loss is 745 W. What is the value of induced rotor current when the motor is in motion? (3 marks)
- (vi) From the induced rotor current determined in part (v), what is the rotor copper loss and air gap power? (4 marks)
- (vii) Calculate the efficiency of the motor if the core loss is 500 W and the stator copper loss is 2 kW. (2 marks)

Question 4

- (a) At the end of the question paper is a returnable copy containing a figure that shows a salient-pole rotor. Clearly label each part pointed by the arrow and attach the returnable copy together with the answer script. (7 marks)
- (i) The stator encased in the housing of the rotor shown in figure Q4(a) in the returnable copy is subjected to a line-to-line voltage with the following expression:
 $588 \cos (120 \pi + 60^\circ) \text{ V}$.
 If the expected speed of rotation is 1,200 rpm, deduce the number of poles. (4 marks)
- (ii) What are the kinds of voltage generated by a synchronous machine? How are they generated? (6 marks)

- (b) The armature leakage reactance and armature-reaction reactance for the figure in part (a) are $1.5 \Omega/\text{phase}$ and $1.22 \Omega/\text{phase}$, respectively. The armature current drawn is $134.91 \angle 96.87^\circ$.
- (i) What is the power factor that this synchronous machine is operating at? (4 marks)
- (ii) What is the power angle this machine is operating at? (4 marks)

Question 5

- (a) The following test results are obtained from tests performed on a 50-Hz, 15-kVA, 2,200/200 V transformer:
- Open circuit (LV side meter readings): 220 V, 2.72 A, 185 W
- Short circuit (HV side meter readings): 112 V, 6.3 A, 197 W
- Determine:
- (i) iron loss (2 marks)
- (ii) copper loss at rated power (6 marks)
- (iii) rated power efficiency at 0.8 power factor lagging (5 marks)
- (b) The primary winding of a 50-kVA, single phase transformer is connected to 2.2-kV, 50-Hz A.C. supply source. There are 600 turns on primary, and 40 turns on secondary of the transformer. Calculate for ideal transformer:
- (i) the no-load voltage across the secondary terminals (5 marks)
- (ii) the full-load currents of both primary and secondary sides (7 marks)

Question 6

- (a) A 750 kW, 11 kV, 3-phase, star-connected synchronous motor has a synchronous reactance of $35 \Omega/\text{phase}$ and negligible resistance. Determine the excitation voltage per phase when the motor is operating on full load at 0.8 power factor lagging with 93% efficiency (10 marks)
- (b) A 100 hp, 3-phase, star connected, 60 Hz, 420 V, 4-pole cylindrical rotor synchronous motor is operating at rated conditions at 80% leading power factor. The efficiency, excluding field and stator losses, is 96% and the synchronous reactance is $2.72 \Omega/\text{phase}$. Determine:
- (i) developed torque (4 marks)
- (ii) armature current (5 marks)
- (iii) excitation voltage (4 marks)
- (iv) power angle (2 marks)

--THE END--

Returnable Copy

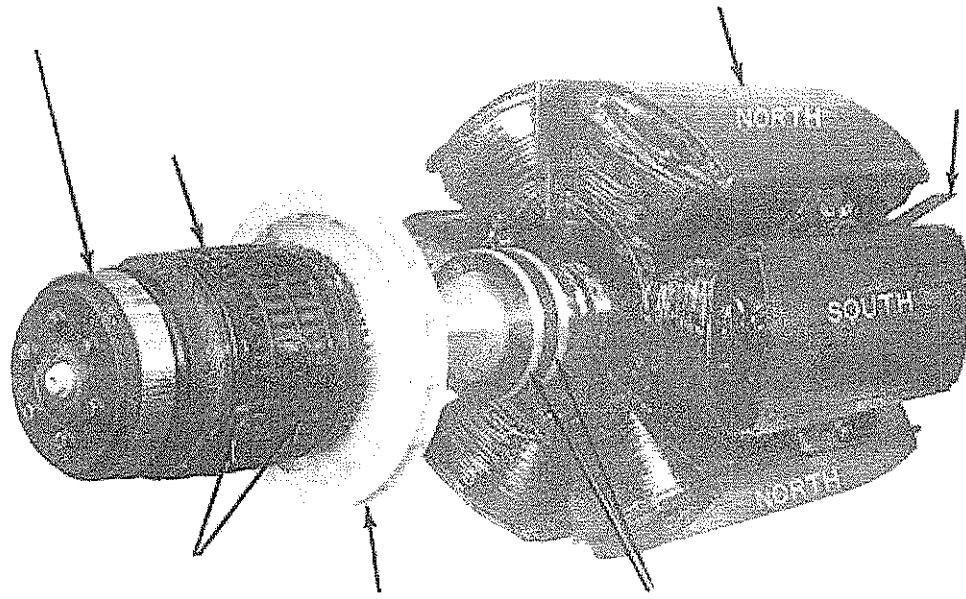


Figure Q4(a): Salient-pole rotor