UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	ELECTRIC MACHINES AND DRIVES
COURSE CODE	:	BEE 4123
PROGRAMME	:	4 BEE
EXAMINATION DATE	:	APRIL/MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS PAPER CONSISTS OF (7) PAGES

Q1 (a) The magnetic circuit in Figure Q1(a) provides flux two (2) air gaps. The coils (N_1=700, N_2=200) are connected in series, the relunctance of the iron is 2800 and carry a current I, 0.5 ampere. Neglect leakage flux.

(i) Draw the magnetic equivalent circuit.
(ii) Determine the total flux.
(iii) Calculate the air gap flux density.
(iv) The magnetic field intensity in the air gap.
(v) Assume 5% increase in the effective area of the air gap due to fringing effects, calculate the new flux in the core.

(19 marks)

(b) Breifly explain two (2) types of losses in a ferromagnetic core

(6 marks)

Q2 (a) A 1ø, 100 kVA, 11000/2200 V, 60 Hz transformer has the following parameters.

$R_{HV} = 6.0\Omega$
$R_{LV} = 0.28\ \Omega$
$L_{HV} = 0.08\Omega$ H
$L_{m(HV)} = 160\text{H}$
$R_{c(HV)} = 125\text{k}\Omega$
$L_{LV} = 0.0032\text{H}$

Standard no-load and short-circuit tests are perfumed on this transformer.

(i) Determine the open circuit test result and short circuit result , V_{OC}, I_{OC} , P_{OC}, V_{SC}, I_{SC} *and* P_{SC}.
(ii) Obtain an equivalent circuit of the transformer, referred to the high-voltage side and referred to the low-voltage side.
(iii) Determine the voltage regulation at full load, 0.6 power factor leading.
(iv) Draw the phasor diagram for condition (iii).

(19 marks)

(b) With an appropriate diagrams, explain briefly procedure in order to perform Open Circuit Test and Short Circuit Test on transformer.

(6 marks)

Q3 (a) Explain three methods of controlling the speed of induction motor.

(6 marks)

(b) A 3 ø, 460V, 50Hz, 4 pole, induction motor produce 100hp at the shaft at 1460rpm. Determine the efficiency of the motor if the rotational losses are 3500W and stator copper losses are 3000W.

(5 marks)

(c) A 3 ø, 440V, 50 Hz, 6 pole, Δ-connected induction motor has the following parameter referred to the stator.

$$R_1 = 0.1\Omega$$
$$X_1 = 0.7\Omega$$
$$X_m = 35\Omega$$
$$R_2' = 0.3\Omega$$
$$X_2' = 0.7\Omega$$

The rotor is running at 960 rpm and the rotational loss is 700W.

(i) Based on the information given, draw the equivalent circuit.
(ii) Calculate the torque and the corresponding slip.
(iii) Determine the value of external resistance required in each phase of the rotor when the maximum torque occurs at the starting point.

(14 marks)

Q4 (a) Two (2) generators of similar size are operating in parallel. From this condition, explain briefly the way to adjust the reactive power sharing between generators without changing terminal voltage, V_T and the way to adjust terminal voltage, V_T without changing the reactive power sharing.

(4 marks)

(b) Explain briefly one (1) approach can be used to safely start a synchronous motor.

(1 mark)

(c) A three-phase Y-connected synchronous generator has the following specifications:

Line Voltage = 415 V	$I_{F,max}$ = 10 A,
Frequency = 50 Hz,	R_F = 20 – 200 Ω
Power Factor = 0.8 lagging	Armature Resistance, R_A = 0.5 Ohms
Generator Rating = 500 kVA	Synchronous Reactance, X_S = 2 Ohms
Pole = 2	Friction and Windage Losses, $P_{f\&w}$ = 30 kW
V_{DC} = 200 V	Core Losses, P_{core} = 15 kW

The generator is connected with a three-phase Δ-connected synchronous motor with load impedance, $Z_L = 10\angle 30^\circ$ Ω. Figure Q4 (c) show the graph for open circuit characteristic. Based the information given, answers the following questions.

(i) Sketch and label three-phase circuits for the generator and motor whereby both circuits are connected.
(ii) Calculate the internal generated voltage, E_A of the generator at rated conditions.
(iii) Estimate the field current, I_F when the generator is running at rated conditions with terminal voltage, V_T equal to 415 V.
(iv) Compute input power, P_{IN} and required torque, τ_{APP} in order the generator is able to supply power to the motor.
(v) If the generator is connected with the load, Z_L and field current, I_F of the generator has been increased to 7A, find new terminal voltage, E_A of the generator. Sketch the per-phase circuit to represent machines connection.
(vi) Sketch the phasor diagram of the generator after load is connected.
(vii) Find the efficiency of the generator.

(20 marks)

Q5 (a) Identify the major advantages of DC motors.

(2 marks)

(b) Sketch the equivalent circuit for any 3 types of DC motors.

(3 marks)

(c) A 230 V, 15 hp, 1800 rpm dc shunt motor has a full load armature current of 60 A when operating at rated conditions. It's characteristic are:

R_A =0.15Ω
R_F =80Ω
R_{adj} =0-200Ω (Currently set to 90Ω)

Armature reaction is ignored. Tabular form below is the magnetization curve of this motor and taken at a speed of 1800 rpm.

E_A, V	8.5	150	180	215	221	226	242
I_F, A	0.00	0.80	1.00	1.28	1.35	1.44	2.88

Calculate:
(i) The speed of the motor when it is running at rated conditions.
(ii) The output torque of this motor when the output power is 7.5 hp at rated conditions.
(iii) The copper losses and rotational losses in this motor at full load (ignore stray losses).
(iv) The efficiency of this motor at full load.
(v) If the motor is now unloaded without changing the terminal voltage or R_{adj}, what is the no-load speed of the motor.
(vi) What would happen to this motor if its field circuit were to open? And what is the speed under this condition. *(Ignore the armature reaction)*
(vii) What range of no-load speeds is possible in this motor according to the minimum and maximum range of R_{adj}.

(20 marks)

Q6 (a) List four advantages of electric drives.

(4 marks)

(b) Typically in motion control of electric drives, it has four types of closed-loop control. Sketch any three (3) of their block diagram and interpret the main function of each control respectively.

(21 marks)

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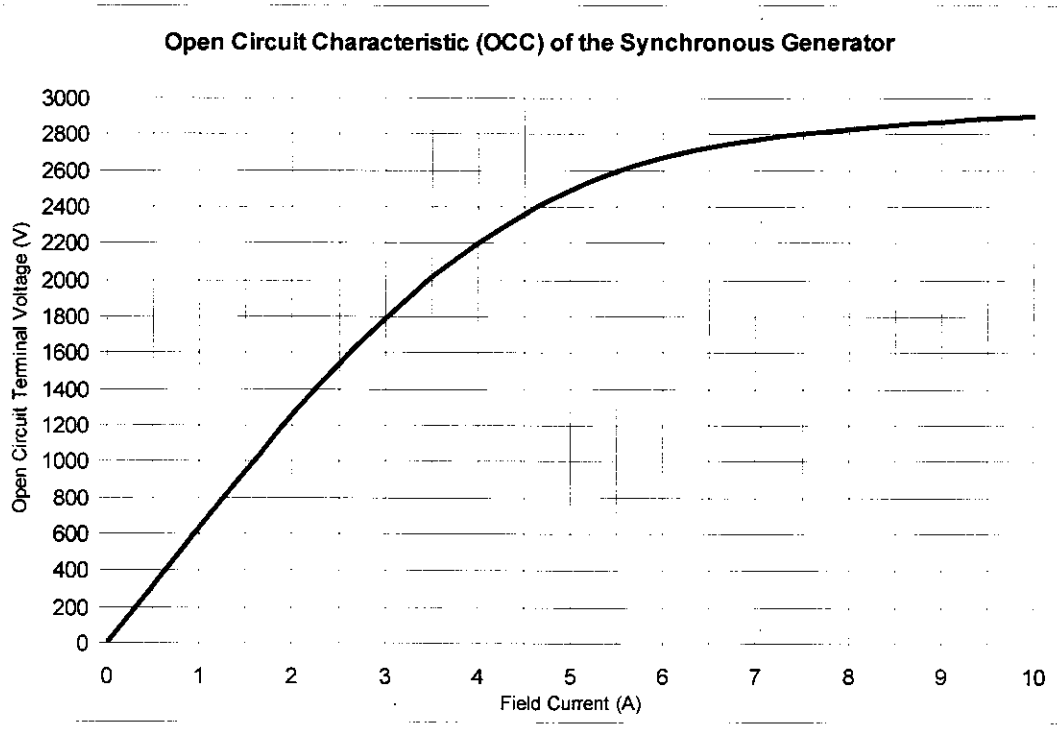

FIGURE Q3(c)