Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	ELECTRICAL MACHINES
COURSE CODE	:	BEF 24103
PROGRAMME	:	BEV
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Name the "Rule" for motor action as depicted in Figure **Q1(a)**. Draw the direction of the conductor (*L*).

(2 marks)

(b) Express the relationship between force (*F*), magnetic field (*B*), current (*i*), and conductor length (*L*). If the force of the conductor is to be designed as 200 Newton with the total current flowing inside the 50 Tesla magnetic field of 10 Ampere, choose a proper length for the conductor used.

(3 marks)

(c) A 15 kVA, 2300/230 V, 50 Hz transformer is to be determined. The open-circuit and the short-circuit tests have been performed on the primary side of the transformer with the obtained experimental data as given in Table **Q1(c)**:

(i) Examine the equivalent circuit referred to the secondary side and sketch the equivalent circuit

(16 marks)

(ii) Predict the voltage regulation for this transformer if it is serving a lagging 0.85 loads in rated conditions

(2 marks)

(iii) Recommend two (2) approaches to increase the transformer efficiency

(2 marks)

Q2 (a) List two (2) advantages of inverter start implemented in an induction motor.

(1 mark)

(b) (i) Explain the different of magnetising curves between transformer and induction motor as shown in Figure **Q2(b)**

(2 marks)

(ii) Sketch and label the torque-speed characteristics for a typical induction motor

(3 marks)

(c) A 415 V, 50 Hz, Y-connected, 4-pole induction motor is rated at 20 horse-power (hp). Its equivalent components data are as follows:

<u>Stator circuit</u>:
$R_1 = 0.44\ \Omega,\ X_1 = 1.25\ \Omega$
<u>Rotor circuit</u>:
$R_2 = 0.40\ \Omega,\ X_2 = 1.25\ \Omega$
<u>Magnetising circuit</u>:
$R_C = 350\ \Omega,\ X_M = 27\ \Omega$

The motor mechanical losses and core losses are *262 W* and *150 W*, respectively. The motor is operating at slip value of 3%.

(i) Analyse the motor stator current and the rotor current

(8 marks)

(ii) Predict the starting current of this motor. Evaluate the percentage of inrush current as compared to its stator current

(3 marks)

(iii) Investigate the efficiency of this motor

(4 marks)

(iv) Compare the induced torque and the load torque of this motor

(4 marks)

Q3 A 72 kVA, 415.7 V, 50 Hz, Y-connected, 4-pole synchronous generator has a per phase reactance of 1 Ω and negligible per phase armature resistance. Its full-load armature current is 100 A, the mechanical losses are 1 kW and the core losses are 0.5 kW. The field current has been adjusted so that the terminal voltage is 415.7 V at no-load conditions.

(a) Find the rotation speed for this generator in rad/s.

(2 marks)

(b) Show two (2) differences between synchronous generator and synchronous motor.

(4 marks)

(c) Analyse the terminal voltage (V_T) of this generator if it is connected to a load at

(i) 0.85 PF lagging

(6 marks)

(ii) Unity PF

(4 marks)

(iii) 0.85 PF leading

(6 marks)

(d) Predict the efficiency of this generator and its voltage regulation when it operates at rated current of 0.85 PF leading.

(3 marks)

Q4 (a) State a reason of the using the starting resistors in DC motors.

(1 mark)

(b) Cumulatively-compounded DC motor combines the best features of both the shunt and the series motors.

(i) Explain briefly those features

(2 marks)

(ii) Sketch the torque-speed characteristics for both shunt and series DC motors

(2 marks)

(c) Analyse what will happen if a load is increased in a shunt DC motor.

(5 marks)

(d) The magnetisation curve for a DC shunt motor operating at 1150 rpm may be represented by the equation, $E_A = (250I_F)/(0.5 + I_F)$. The open-circuit voltage, E_A is in volts, while the shunt-field current, I_F is in amperes. Data for the machine are as follows:

$R_A = 0.20\ \Omega$ $\quad V_T = 220$ V

$R_F = 100\ \Omega$ $\quad L_F = 0.1$ H

When the motor is operating at full-load, the shunt-field current, I_F is estimated as 2% of the full-load armature current, I_A.

(i) If R_{adj} is adjusted to 40 Ω, analyse the speed of the motor at full-load

(10 marks)

(ii) Investigate the no load speed for the condition in part **Q4(d)(i)**

(3 marks)

(iii) Predict the speed regulator for the condition in part **Q4(d)(ii)**

(2 marks)

– END OF QUESTION –

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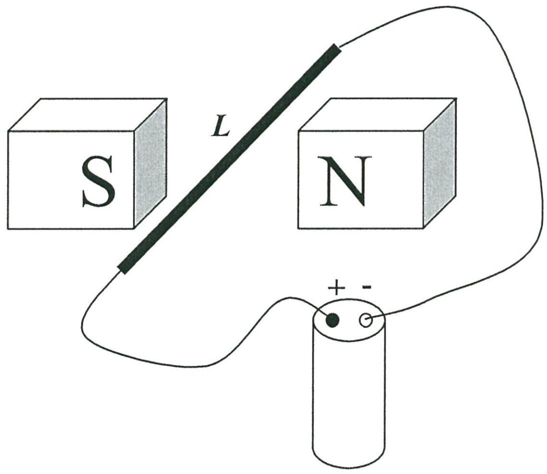

FIGURE Q1(a)

TABLE Q1(c)

Open-circuit test (on primary)	Short-circuit test (on primary)
$V_{OC} = 2300$ V	$V_{SC} = 47$ V
$I_{OC} = 0.21$ A	$I_{SC} = 6.0$ A
$P_{OC} = 50$ W	$P_{SC} = 160$ W

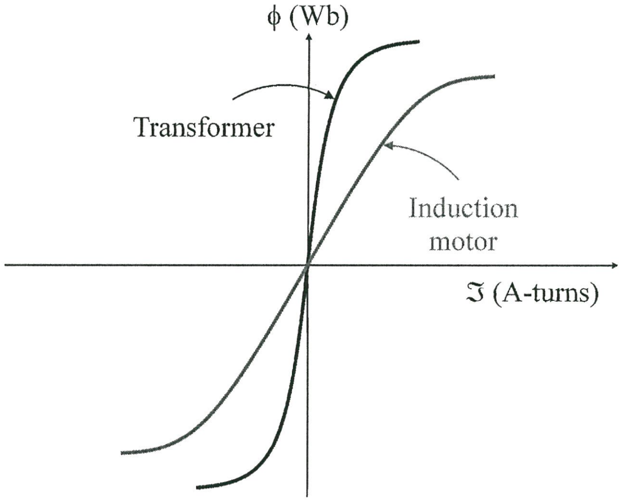

FIGURE Q2(b)