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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ELECTRICAL DRIVES
COURSE CODE	:	BEF 35803
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

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Q1 (a) Illustrate and explain in detail **TWO (2)** techniques use for a DC electric motor braking.

(10 marks)

(b) A 340 V, 1200 rpm, 120 A, DC separate excited motor has braking resistance of $R_a = 0.1\Omega$. A braking has occurred using plugging method from an initial speed at 1400rpm. Calculate:

(i) the resistance to be placed in the armature circuit to limit the braking current up to twice the full load value

(5 marks)

(ii) the braking motor torque

(5 marks)

(iii) the new initial braking current and braking power if the braking resistance is increased to 4Ω

(5 marks)

Q2 (a) Explain and illustrate in detailed **FOUR (4)** commonly used DC Motor in electrical drives.

(12 marks)

(b) A two pulse, bridge converter is used to control the speed of a separately excited DC motor rated at 10 HP, 200 V, 50 Hz feed with an armature resistance $R_a = 0.6\ \Omega$ and the armature inductance $L_a = 6$ mH. The motor constant is given as $K_e\Phi = 0.05$ V/rpm. If the DC motor is running at 1300 rpm and carries an armature current of 37 A. Calculate:

(i) the firing angle (α) of the converter

(6 marks)

(ii) the power delivered to the motor

(2 marks)

(iii) the supply power factor

(5 marks)

Q3 (a) Explain and illustrate in detail **TWO (2)** methods which been used for controlling the speed of an electrical motor.

(10 marks)

(b) A three-phase 410 V, 50 Hz mains is use for a fully-controlled (6-pulse converter), on a 100 HP, 500 V, 1600 rpm, separately excited DC motor. The motor parameters are given:

$$I_a = 140 \text{ A}$$
$$R_a = 0.066\ \Omega$$
$$L_a = 5.1 \text{ mH}$$
$$K_e\Phi = 0.05 \text{ V/rpm}$$

(i) Calculate the no-load speed at firing angle $\alpha = 0$ and $\alpha = 27$. Assuming at no-load, the armature current is 10% of rated current and is in continuous mode

(9 marks)

(ii) Determine the firing angle, α when at 1400rpm and in current rated value.

(6 marks)

Q4 (a) Your company has bought a lithium-ion batteries as backup for powering a motor compressor use in the department. Classify in details, the motor drive system with the newly bought batteries with the aid of block diagram and speed torque characteristics.

(5 marks)

(b) The modern application of motor control can be applied using a microcontroller where the electrical motor and control command can be developed without any additional equipments. List the advantages of this application for motor control.

(5 marks)

(c) A 370 V, four-pole, 50 Hz, Y-connected wound-rotor induction motor is rated at 15 HP. The motor has the following parameters:

$R_s = 0.22\ \Omega$ $R_r = 0.11\ \Omega$ $X_m = 20\ \Omega$

$X_s = 0.41j$ $X_r = 0.41j$

For a slip of 0.07,

(i) calculate the rotational speed (Nm) and synchronous speed (Ns)

(3 marks)

(ii) illustrate the equivalent circuit of the induction motor with the given parameters

(2 marks)

(iii) calculate the line current (or armature current)

(6 marks)

(iv) find the air gap power (P_{AG})

(2 marks)

(v) find the power generated from electrical to mechanical (P_{CONV})

(2 marks)

- END OF QUESTIONS -

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FORMULA

$$E = \frac{1}{2} J\omega^2$$

$$E = \frac{1}{2} Mv^2$$

$$T = B\omega$$

$$E = K\phi\omega$$

$$T = J\frac{d\omega}{dt} + T_L + B\omega$$

$$I_r = \frac{V}{\left(R_s + \frac{R_r}{s}\right) + j(X_s + X_r)}$$

$$T = \frac{3}{\omega_{ms}}\left[\frac{V^2 R_r / s}{(R_s + \frac{R_r}{s})^2 + (X_s + X_r)^2}\right]$$

$$P_e = P_m$$
$$P_m = P_{rotor} + P_{copper}$$
$$P_{AG} = 3I_A^2$$
$$P_{CONV} = (1 - s)P_{AG}$$
$$P_{rotor} = 3I_r^2 R_{r/s}$$
$$P_{copper} = 3I_r^2 R_r$$

$$s_m = \pm\frac{R_r}{R_s \pm \sqrt{R_s^2 + (X_s + X_r)^2}}$$

$$T_{max} = \frac{3}{2\omega_{ms}}\left[\frac{V^2 R_{r/s}}{R_s \pm \sqrt{R_s^2 + (X_s + X_r)^2}}\right]$$