UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	ELECTRIC DRIVES
COURSE CODE	:	BEF 35803
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JUNE/JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS ALL QUESTIONS

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

Q1 (a) As an electrical engineer in SAZ Sdn. Bhd., propose a suitable modern electrical drive system with the aid of block diagram if necessary and stated **ONE (1)** disadvantage and advantage for every case below:

(i) A 3-phase induction motor is required to change the voltage at every 3 hours if the same load is installed at the induction motor.

(3 marks)

(ii) A 1-phase induction motor is applied to a load that requires high max torque but low initial speed at no-load torque condition.

(3 marks)

(iii) A 3-phase induction motor that will give high starting current, high maximum torque, high rotor speed, and high starting torque.

(4 marks)

(b) Power modulators are one of the vital parts of an electrical drive system. Briefly describe the types of power modulators for electrical drives system as listed below:

(i) Converters.

(4 marks)

(ii) Variables impedances.

(3 marks)

(iii) Switching circuits.

(3 marks)

Q2 (a) There are several methods that can be used to control the speed of the induction motor. One of the techniques is by introducing the secondary voltage V_i' at the rotor part.

(i) With the aid of simplest equivalent circuit of induction machine, prove the rotor current I_2' is $I_2' = \dfrac{V_s - \frac{V_i'}{s}}{\sqrt{(R_1 + \frac{R_2'}{s})^2 + X_{eq}^2}}$

(4 marks)

(ii) Illustrate the speed torque characteristic of the injected rotor voltage if the voltage is given by $V_i' > V_{ia} > V_{ib} > V_{ic}$

(2 marks)

(b) A standard 3-phase, 20 HP, 415 V, 50 Hz and two-pole squirrel-cage induction motor develops a torque of 80 N.m at a speed of 1200 r/min. The synchronous speed of the motor is 1500 r/min. The motor is connected in Y arrangement to the source input and has inductive reactance of 4 Ω, stator resistance 0.2 Ω and rotor refer to stator is 0.3 Ω, calculate:

(i) the maximum frequency of the supply voltage that will not result to the stalling the motor.

(5 marks)

(ii) the motor current at 50 Hz and the maximum frequency.

(7 marks)

(iii) the power delivered to the load at 50 Hz and at the maximum frequency.

(2 marks)

Q3 (a) The modern speed control is implementing a Voltage/Frequency control strategy. This strategy is able to control both the speed and torque of the rotor at the same time. The condition to have this control is when the $X_{eq} \lll R_1$. This condition has been applied to a single phase induction machine that has 240V, 50Hz, 80N.m and the electrical equivalent values are $R_1 = 0.4\ \Omega, R_2 = 0.5\ \Omega, X_1 = 0.35\ \Omega, X_2 = 0.25\ \Omega$, and $\frac{N_2}{N_1} = 0.5$.

(i) Determine the rotor speed in rad/sec if the input frequency is reduced to 35 Hz.

(4 marks)

(ii) Calculate the starting current at 50 Hz and 35 Hz and state the reasons of this value.

(4 marks)

(b) A 210V, three-phase, six pole, 50Hz, Y-connected induction motor has $R_1 = 0.128\ \Omega$, $R'_2 = 0.0935\ \Omega$ and $X_{eq} = 0.49\ \Omega$, calculate:

(i) the starting current,

(2 marks)

(ii) full-load current,

(2 marks)

(iii) starting torque,

(2 marks)

(iv) maximum torque,

(2 marks)

(v) motor efficiency,

(2 marks)

(vi) redraw the speed-torque characteristics of this motor with the corresponding explanation to this curve.

(2 marks)

Q4 (a) State **two (2)** disadvantages of a resistance starter.

(2 marks)

(b) A 250 kW, 400 V, 3-phase, 2983 r/min, 50 Hz induction motor has a locked-rotor torque of 800N.m and a locked-rotor current of 1600 A. Three resistors are connected in series with the line to reduce the voltage across the motor to 0.70 pu. Determine:

(i) The apparent power absorbed by the motor when the resistors are in the circuit.

(4 marks)

(ii) The apparent power drawn from the line when the resistors are in the circuit.

(2 marks)

(c) If the power factor of the locked-rotor motor as described in **Q4(b)** is given by 0.4;

(i) Calculate the power dissipated by the series resistors.

(10 marks)

(ii) Determine the value of the series resistors.

(2 marks)

Q5 (a) A 240 V, 475 A, 500 r/min separately excited DC motor has an armature and field resistance of 0.01 Ω and 20 Ω, respectively. The load torque is given by $T_L = 2500 - 3N$, where N is the speed in r/min. Speeds below the rated are obtained by armature voltage control and speeds above the rated are obtained by field control. Calculate the field winding voltage and armature current when the speed is 700 r/min.

(10 marks)

(b) A 240 V, 2000 r/min, 100 A separately excited DC motor with armature resistance of 0.5 Ω, is fed from a 3-phase fully controlled rectifier. Available AC source has a line voltage of 415 V, 50 Hz. A star-delta connected transformer is used to feed the armature so that motor terminal voltage equals to rated voltage when converter's firing angle is zero.

(i) Determine the transformer turn ratio.

(4 marks)

(ii) Determine the firing angle when the motor is running at -1400 r/min with twice of the rated torque.

(6 marks)

- END OF QUESTIONS -