Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	ELECTRONIC DRIVES AND APPLICATION
COURSE CODE	:	BND 40903
PROGRAMME CODE	:	BND
EXAMINATION DATE	:	JUNE / JULY 2016
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) Sketch a simple diagram of a single-phase, two winding transformer comprising of primary turns and secondary turns. From this diagram, obtain an equivalent electric circuit for primary and secondary as well as core loss and the magnetizing component.

(5 marks)

(b) From the transformer equivalent circuit, obtain the per phase equivalent circuit for a three-phase induction motor with all components referred to the stator side.

(5 marks)

(c) Simplify the equivalent circuit in (b) above by considering the magnetizing reactance as many times greater than the stator leakage reactance ($X_m >> X_1$) and ignoring the coreloss component (R_c), obtain

(i) the Thevenin equivalent circuit components of V_{th}, R_{th} and X_{th} to replace V_1, R_1, X_1 and X_m of a per phase equivalent induction motor circuit.

(5 marks)

(ii) the rotor torque developed in terms of circuit parameters at a slip of **s**

(5 marks)

(iii) the maximum slip $\mathbf{s}_{max}$ at which the maximum rotor power occurs

(5 marks)

Q2 (a) Draw and label a standard 3-phase Voltage Controlled Inverter (VSI) circuit comprising of six switches and fed by a DC voltage source and the inverter output is fed to a star-connected stator windings of a squirrel-cage induction motor.

(5 marks)

(b) Suppose the inverter in (a) above uses the 180^o on-period for each of the six switches and the operating frequency of 25 Hz is required while the DC input supply is 200V:

(i) Produce a switching sequence table showing the ON period of each switch during each output cycle

(5 marks)

(ii) Draw the phase voltage waveforms against time by adopting positive sequence rotation

(6 marks)

(iii) From the phase voltage waveforms produced in (ii) above, obtain the line voltage waveforms

(6 marks)

(iv) Compute the RMS value of the line voltage obtained in (iii) above

(3 marks)

Q3 (a) Figure Q3(a) shows a separately excited DC motor with parts shown during steady state. By writing equations for V_t, E_a and motor torque τ_{ind} show that the speed of the DC motor can be expressed as:

$$\omega_m = \frac{V_t}{K\phi} - \frac{R_a}{(K\phi)^2}\tau_{ind}$$

(8 marks)

(b) Draw and label the torque-speed curve given by : $\omega_m = \frac{V_t}{K\phi} - \frac{R_a}{(K\phi)^2}\tau_{ind}$

(4 marks)

(c) Figure Q3(c) shows a simple DC motor speed controller circuit comprising of zero crossing detection; constant current generation; current charging a capacitor; ramp waveform generation; comparison of two voltage waveforms; opto-isolation of triggering signal as well as a permanent magnet DC motor.

(i) Produce the waveforms indicated by alphabets from A till G on the circuit diagram.

(5 marks)

(ii) Briefly describe the function of each part of the circuit.

(8 marks)

Q4 (a) Switched reluctance motor (SRM) is gaining popularity like that of Brushless DC (BLDC) motor but works on different principles. Explain, with the aids of diagram(s), the working of the SRM of a three-phase type stator and a soft iron rotor (preferably explain with an example of a two poles per phase stator and a 4-pole rotor).

(8 marks)

(b) The usage of Brushless DC (BLDC) motor is becoming increasingly popular in industry nowadays.

(i) Explain the structure and working of BLDC with the aid of diagrams for a three-phase, 6-pole stator and a 4-pole rotor motor. Show clearly the sequence of switching on the supply to the stator coils in order to obtain a full revolution of the rotor.

(10 marks)

(ii) Explain whether any sensing devices were required for proper and successful operation of the motor.

(5 marks)

(iii) List **FOUR** (4) applications where BLDC motors are being used.

(2 marks)

Q5 (a) With the aid of diagrams, explain the following as applied to stopping of three-phase asynchronous motors in industry:

(i) Plugging

(4 marks)

(ii) Dynamic braking

(4 marks)

(b) Frequently ordinary constant speed induction motors are being used for variable speed drive to save cost. If the inverter used to drive this type of induction motor is of the PWM type, list the disadvantages or risks that may arise.

(8 marks)

(c) If you were given the job of servicing and maintenance of electric drives of a manufacturing plant, briefly explain how do you go about the job. List out the work that you are planning to do and give reason(s) as why you want to do it.

(9 marks)

-END OF QUESTIONS –

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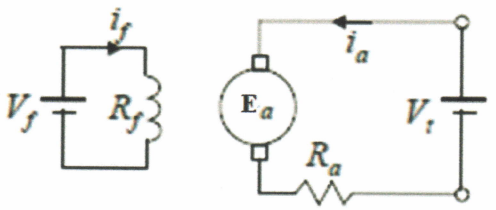

Figure Q3(a)

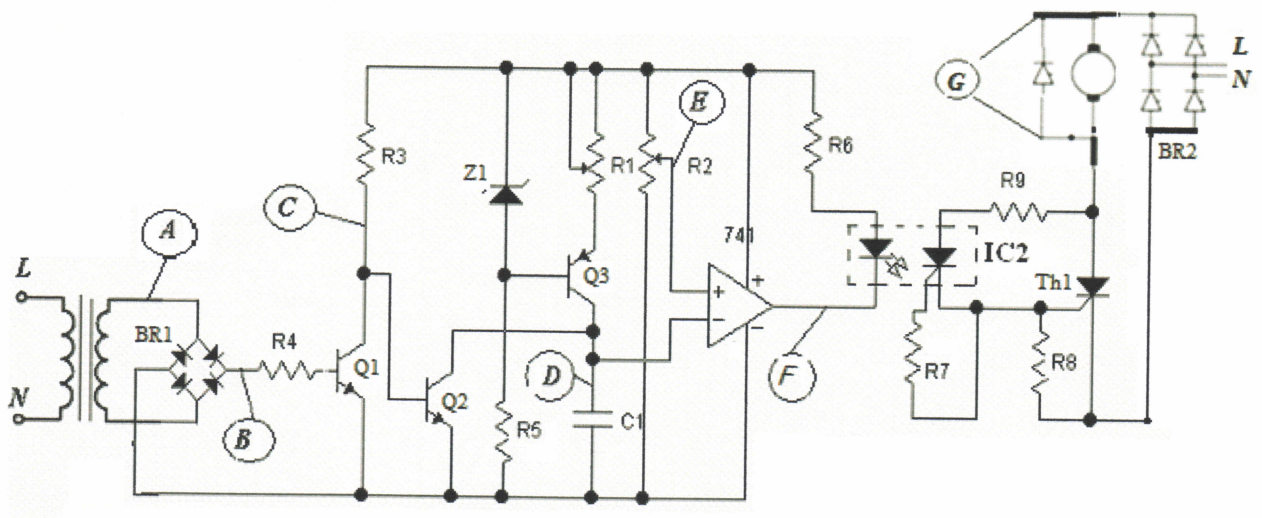

Figure Q3(c)