



**UTHM**  
Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2014/2015**

COURSE NAME : ELECTRONIC DRIVES AND APPLICATION  
COURSE CODE : BND40903  
PROGRAMME : 3 BND  
EXAMINATION DATE : JUNE 2015 / JULY 2015  
DURATION : 2½ HOURS  
INSTRUCTION : ANSWER **FOUR (4)** QUESTIONS ONLY

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

- (b) Suppose a DC voltage of 309 V is available and is to be connected to a 6-switch bridge circuit with the top switches as S1, S3 and S5 while the corresponding bottom switches as S4, S6 and S2 respectively as is depicted in **Figure Q3(b)**. Show that by closing and opening the switches in sequence and in rotation, and that each switch being switched on for a period of  $180^\circ$ , a three-phase voltage is impressed upon the stator windings. Using  $V_{AB} = V_A - V_B$  and so on, obtain the magnitude and phase angle of the line voltages in RMS across the motor terminals.

( 15 marks)

**Q4** You are given a separately excited DC motor rated at 220V, 1.5 kW. You are to come out with a control circuit to control the speed of that motor. You are free to keep the field voltage constant and vary the input to the armature or you can supply a constant voltage to the armature but vary the input to the field coil. Whichever method you choose, you still need to provide the following:

- A +15V – 0 – -15V supply using readily available IC parts. You can show the power supply circuit as a standalone circuit.
- A zero crossing circuit preferably using a signal transformer of  $6V_{RMS}$ , rectify the ac to dc and sense it with a transistor Q1. Pulse signal from Q1 is to supply to Q2 and when Q2 is on, it discharges the voltage across a capacitor C1. This capacitor C1 is part and parcel of an integrator circuit (designated as IC1) consisting of C1 and a trimmer VR1 marked with 50 kilo-ohm. This trimmer is to be connected to a -15V supply to provide a constant current of 50 mA.
- The output from the integrator in the form of a ramp is to be compared with a control voltage  $V_{CONTROL}$  from the middle pin of a potentiometer connected across the +15V.
- The output of the comparator (designated as IC2) shall connect to the LEDs of two opto-isolators of the SCR output type ( P541G or equivalent ) to provide the appropriate switching pulses to the two SCRs of a semi-fullwave rectifying circuit.
- The output of the semi-fullwave is supplying either to the armature circuit or the field circuit depending on choice. However, you need to show that they must have supply to both armature and field circuit, one fixed, one variable.

With the information given above, do the following:

- (i) Draw the dual power supply circuit indicating the value of transformer, power ICs used, and the output.

( 3 marks)

- Q1** (a) Obtain the equivalent circuit of a transformer first and from which obtain the per phase equivalent circuit of a squirrel-cage induction motor referred to the stator side. (8 marks)
- (b) Sketch and label a typical torque-speed curve of a three-phase induction motor and briefly explain the meaning of the labeling. (7 marks)
- (c) With the help of the voltage waveform of a three phase AC supply and the displacement of  $120^\circ$  of the three separate stator coils, namely R-R', Y-Y', and B-B', show that when the induction motor is supplying with the three-phase voltage, a constant magnitude revolving field is obtained at the stator.  
(Suggestion: Starts with angle =  $0^\circ$  and proceed to  $60^\circ$ ,  $120^\circ$ ,  $180^\circ$  .. until  $360^\circ$ ). (10 marks)
- Q2** (a) The usage of Brushless DC motors or BLDC motors are becoming increasingly popular nowadays in industry.
- (i) Explain the structure and working of BLDC with the aid of diagrams with a three-phase, 6-pole stator and a 4-pole rotor. Show clearly the sequence of switching on the supply to the stator coils to obtain a full revolution of the rotor.
- (ii) Explain if any sensing devices needed for proper and successful operation of the motor. (15 marks)
- (b) Switched Reluctance Motor (SRM) is equally gaining popularity as BLDC but works on different operation principles. With the aids of diagrams explain the working of the SRM of a three-phase type stator and a soft iron rotor. (10 marks)
- Q3** (a) One of the techniques used in making Variable Voltage Variable Frequency (VVVF) inverter is the deployment of PWM. With the aid of diagrams and illustration, show that when carrier triangular waves and the sinusoidal modulating wave were compared in a comparator circuit, the output from the comparator will produce a pulsed modulated wave for one phase of an inverter output, which when apply to one phase of the induction motor stator circuit will form the fundamental waveform having the same frequency as the modulating waveform. (10 marks)

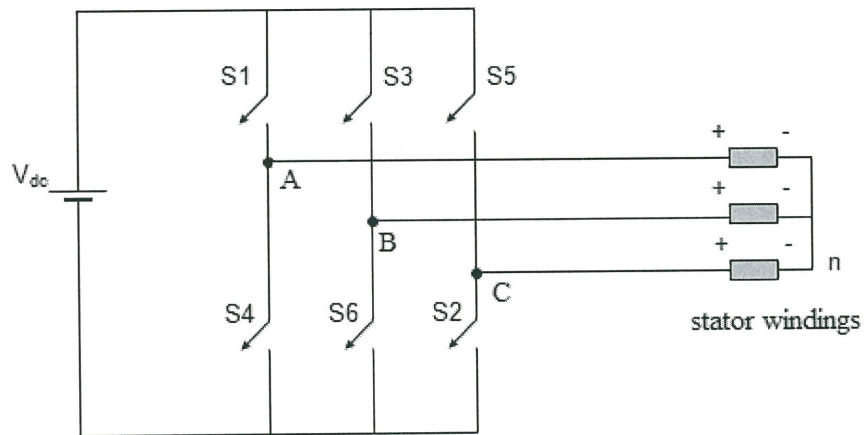
- (ii) Draw the complete control circuit, try to put in appropriate values for the parts used.  
( 8 marks)
- (iii) Draw and arrange the waveforms in a top-down fashion starting from the output from signal transformer, the zero crossing sensor, the integrator output, the  $V_{\text{control}}$ , the comparator output right up to the targeted load.  
( 8 marks)
- (iv) Given the constant current of 50 mA, calculate the value of the trimmer that you need to set.  
( 3 marks)
- (v) Assume that the time between two zero crossing is about 10 ms and the charging current is 50 mA, and supposing the ramp is to charge to 4V before it is discharged, calculate the value of the charging capacitor C1.  
(3 marks)
- Q5** (a) With the aid of diagrams, explain the following as applied to stopping of three-phase asynchronous motors in industry:
- (i) Plugging  
(ii) Dynamic braking  
( 8 marks)
- (b) If you were given the job of servicing and maintenance of electric drives of a manufacturing plant, briefly explain how do you go about it. List out the work that you are planning to do and give reason(s) as why you want to do it.  
( 8 marks)
- (c) 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.  
( 9 marks)

- END OF QUESTION -



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**FIGURE Q3(b)**