



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

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

COURSE NAME : ELECTRIC DRIVES
COURSE CODE : BEF 35803
PROGRAMM : BACHELOR OF ELECTRICAL
ENGINEERING WITH HONOURS
EXAMINATION DATE : JUNE 2015/JULY 2015
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

- Q1** (a) Name and briefly describe the functions of the four types of circuit diagram that are used to represent a control system. (8 marks)
- (b) State in which quadrants a DC machine operates as:
- (i) A motor. (1 mark)
- (ii) A generator. (1 mark)
- (c) As an electrical engineer in SAZ Sdn. Bhd., you have been asked to suggest a suitable modern electrical drive system with the block diagram explanation which stated the disadvantages or advantages for every case below:
- (i) The 3-phase induction motor is required to change the voltage at every 3 hours if the same load is installed at the induction motor. (5 marks)
- (ii) In order to reduce the electricity bill of the company, the starting current generated for the IM must be changed. (5 marks)
- Q2** (a) A standard 3-phase, 20 HP, 415 V, 50 Hz 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. Determine the new speed at a torque of 80 N.m if the motor is excited at a voltage of 249 V at 30 Hz. (3 marks)
- (b) **Figure Q2(b)** represents current-speed and torque-speed curves of a machine excited at 460 V, 60 Hz. By referring to the figure:
- (i) Identify the current in the stator if the machine is running as a motor at 1050 r/min and developing a torque of 140 N.m. (2 marks)
- (ii) Identify the current in the stator when the machine is operating as a motor and developing a breakdown torque. (2 marks)

- (iii) The machine is running as a generator at 1950 r/min and developing a torque of 120 N.m. The thermal relays are set to the current in this condition. If the relay tripping curve is given in **Figure Q2(b)(iii)**, estimate the relay tripping time if the current suddenly rises to 120 A.

(5 marks)

- (c) **Figure Q2(c)** represents the torque-speed characteristic of a 15 HP, 460 V, 3-phase, 60 Hz squirrel-cage induction motor.

- (i) Calculate the new breakdown torque if the motor is energized at 690 V, 60 Hz.

(2 marks)

- (ii) Illustrate the new shape of the curve if the motor is energized with the same voltage as **Q2(c)(i)**.

(6 marks)

- Q3** (a) A 3-phase, 6-pulse rectifier is equipped with a freewheeling diode. The 3-phase feeder has a line voltage of 240 V and the DC load is composed of an armature having a resistance of 0.4 Ω .

- (i) Calculate the voltage required to cause 60 A to flow through the armature when the motor is in locked-rotor condition.

(3 marks)

- (ii) Calculate the firing angle required to achieve the current in **Q3(a)(i)**.

(3 marks)

- (iii) Determine the reactive power absorbed by the converter.

(5 marks)

- (b) An electronic chopper is placed between a 750 V DC trolley wire and the armature of a series motor. The switching frequency of the chopper is 1000 Hz. Each pulse lasts for 300 μs and the DC current in the trolley wire is 82.5 A.

- (i) Calculate the armature voltage of the motor.

(2 marks)

- (ii) Calculate the armature current of the motor.

(2 marks)

- (iii) Illustrate the waveform of the armature voltage of the motor.

(5 marks)

Q4 A 3-phase Δ -connected induction motor, 415 V, six-poles, 50 Hz, has parameters $R_1=0.2 \Omega$, $R'_2=0.65 \Omega$, $X_1=X'_2=0.36 \Omega$, $X_m=0.3 \Omega$. The motor is used to run a pump with a torque-speed curve given by $T_L=0.0014\omega^2$. The motor-pump speed is adjusted by voltage control using a pair of inverse-parallel connected SCRs in the line.

- (a) Draw the electrical equivalent circuit for the motor. (3 marks)
- (b) Determine the rotor current if the motor speed is at 1000 r/min. (3 marks)
- (c) Calculate the motor impedance given in **Q4(a)**. (3 marks)
- (d) Determine the input motor current. (4 marks)
- (e) Calculate the firing angle of the thyristor control if the speed is given in **Q4(b)**. (2 marks)
- (f) Determine the efficiency of the motor when the speed is at 1000 r/min. (5 marks)

Q5 A 3-phase Δ -connected induction motor 415 V, four-poles, 50 Hz, has a stator resistance 0.4Ω and a rotor resistance referred to stator 0.5Ω . The reactance of the stator and motor are given as $X_1=X'_2 = \frac{1}{2} \Omega$ with $\frac{N_1}{N_2} = 2$. Assumed the mechanical loss is zero and the load torque is constant at 80N.m.

- (a) Determine the X_{eq} of the motor if $X_m \gg \gg R_m$. (2 marks)
- (b) Calculate the maximum torque of the motor. (2 marks)
- (c) Determine the new speed of the motor if the motor is located at point A given in **Figure Q5(c)**. (4 marks)

- (d) Calculate the new starting current from the new speed value given in **Q5(c)**. (3 marks)
- (e) Determine the injected voltage at the source that will reduce the motor speed given in **Q5(c)**. (6 marks)
- (f) Draw the new speed-torque characteristic graph with the new condition in **Q5(e)**. (3 marks)

- END OF QUESTIONS -

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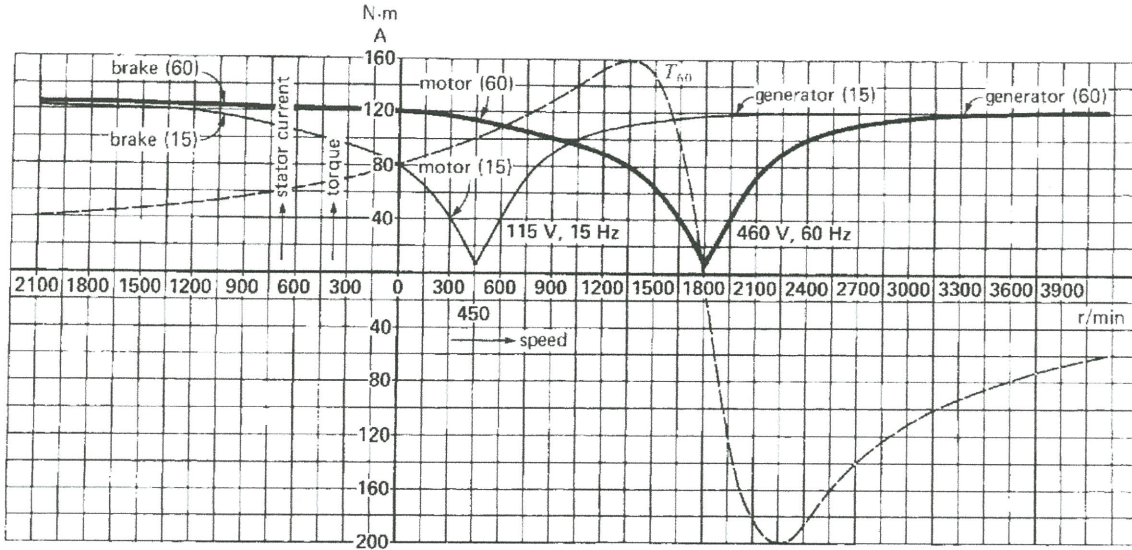


FIGURE Q2(b)

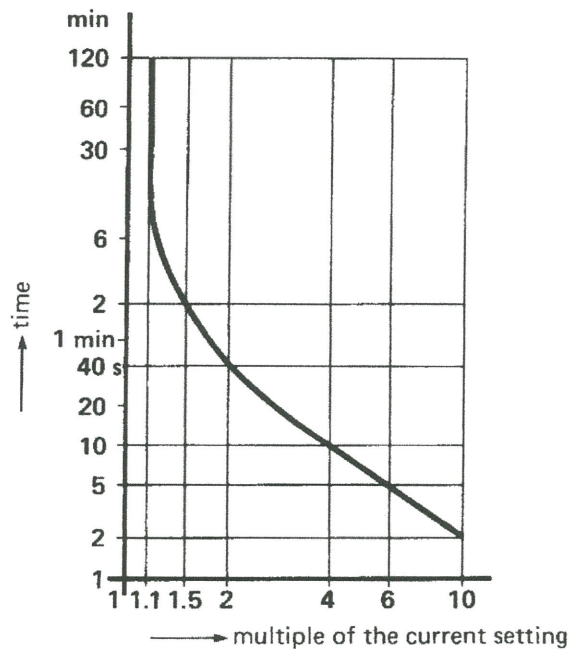


FIGURE Q2(b)(iii)

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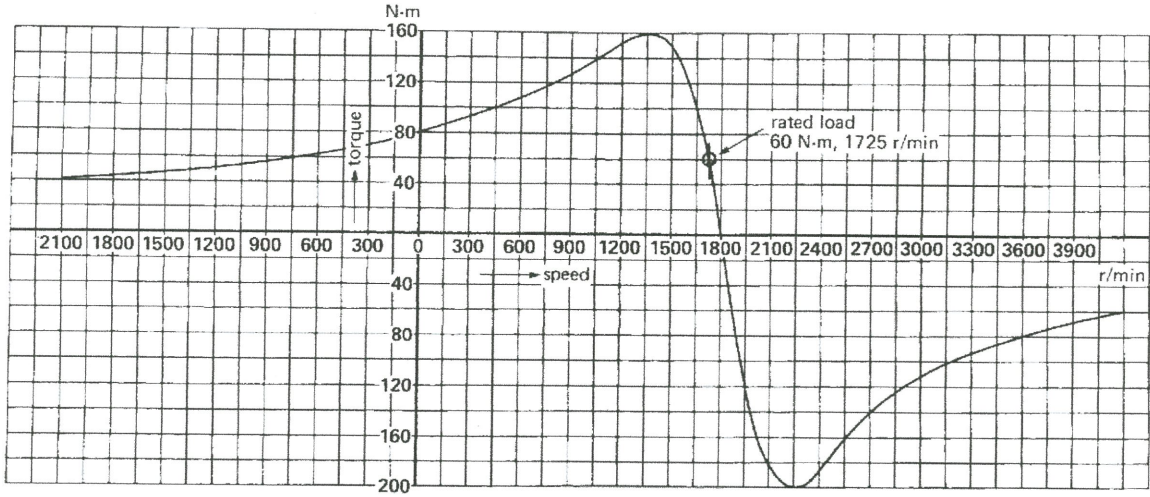


FIGURE Q2(c)

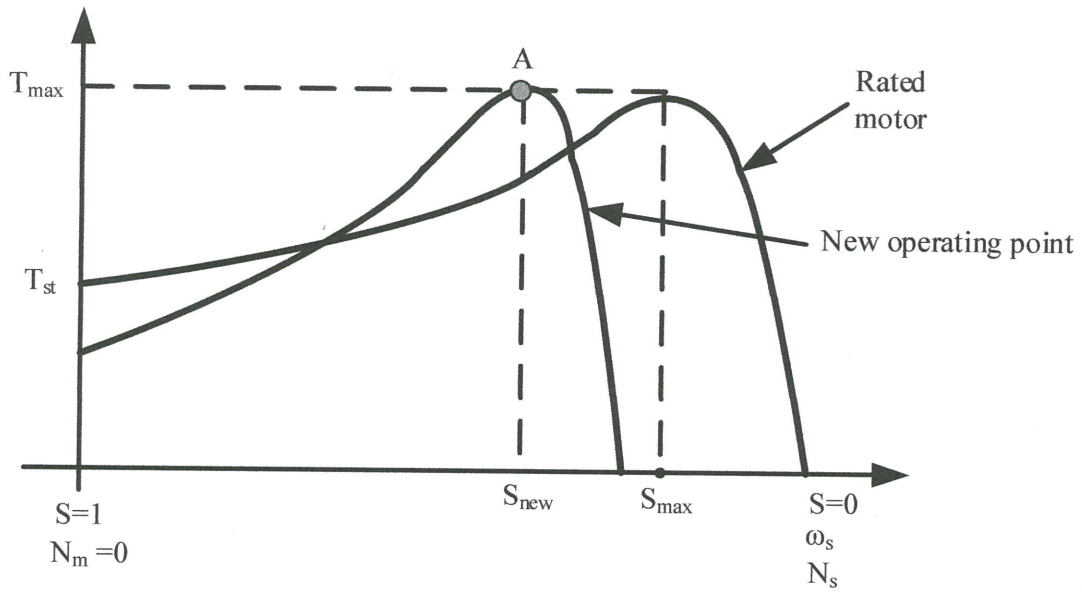


FIGURE Q5(c)