Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ELECTRIC MACHINES & DRIVES
COURSE CODE	:	BND 35703
PROGRAMME CODE	:	BND
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Differentiate any **THREE (3)** types of DC motor by sketching their equivalent circuit diagrams.

(6 marks)

(b) **Figure Q1(b)** shows the torque-speed-current characteristic of a series DC motor. Discuss the condition of this motor when it is loaded.

(5 marks)

(c) A 150 V, 10 hp DC shunt motor delivers power to a load at 1000 r/min. The armature current drawn by the motor is 110 A. The armature circuit resistance of the motor is 0.3 Ω and the field resistance is 85 Ω. If the rotational losses are 250W, determine the following:

(i) Value of the load torque

(5 marks)

(ii) The motor efficiency

(5 marks)

(d) Explain why the armature current of a shunt DC motor decreases as the motor accelerates.

(4 marks)

Q2 (a) The rotor of an induction motor rotates at a speed lower than the synchronous speed. Explain the reasons.

(5 marks)

(b) With the aid of relevant diagrams, differentiate the power flow of an induction motor and DC motor (from stator to shaft).

(5 marks)

(c) A 3-phase induction motor is connected to an AC supply and run at synchronous speed of 1500 r/min which draws 75 kW of power. Given the total losses in the stator is 4.6 kW and the windage/friction losses is 1.8 kW. If the motor runs at 1250 rev/min, calculate the following:

(i) The active power transmitted to the rotor

(ii) The rotor I^2R losses

(iii) The mechanical power developed

(iv) The efficiency of the motor

(10 marks)

(d) **Figure Q2(d)** is the torque-speed characteristic of an induction motor. Label the stable and unstable operating regions and discuss these phenomena.

(5 marks)

Q3 (a) Compare the construction of a synchronous motor and a squirrel-cage induction motor based on their electrical connection to the input source.

(6 marks)

(b) **Figure Q3(b)** shows the synchronous motor rotor pole and stator pole position under no-load and under load conditions. Analyse the diagram and discuss its characteristic.

(5 marks)

(c) A synchronous motor connected to a 4 kV, 3-phase line generates an excitation voltage E_o of 1.8 kV (L-N) is rotating at a speed of 700 r/min when the dc exciting current is 20A. Given the synchronous reactance is 22 Ω and the torque angle between E_o and E is 35°. Calculate :

(i) The value of E_x

(4 marks)

(ii) The AC line current

(2 marks)

(iii) The power factor of the motor

(2 marks)

(iv) The approximate horsepower developed by the motor

(4 marks)

(v) The approximate torque developed at the shaft

(2 marks)

Q4 (a) Using **Figure Q4(a)**, explain the operation on an AC induction motor.

(6 marks)

(b) Explain the conditions of a 3 phase induction motor when

(i) the slip = 1
(ii) the slip less than 1
(iii) the slip is more than 1
(iv) the slip is negative

(6 marks)

(c) List **FIVE(5)** differences of brushless DC motor over conventional DC motor.

(5 marks)

(d) A series-connected DC motor connected to a voltage source of V_{DC} = 220 V has an armature resistance of 0.4 Ω, field winding resistance of 1.2 Ω. and rotates at 1200 rpm, the current drawn by the motor is 10A from. Given the rotational loss is 120 W determine:

(i) The back emf
(ii) The power developed
(iii) The output power

(8 marks)

Q5 (a) Define about electrical drives and explain its advantages

(4 marks)

(b) Sketch the block diagram of an electrical drive with details labelling.

(5 marks)

(c) Analyse the first operating quadrant of electric drive shown in **Figure Q5(c)**. Hence discuss the armature torque and speed control of a DC motor using elctronic converter.

(6 marks)

(d) A 10hp, 240V, 1800 rev/min permanent magnet DC motor has an armature resistance of 0.4 Ω and a rated armature current of 35A. It is energized by the converter shown in **Figure Q5(d)**. If the AC line voltage is 208 V, 60 Hz and the motor operates at full-load, calculate :

(i) The delay angle required so that the motor operates at its rated voltage
(ii) The reactive power absorbed by the converter
(iii) The effective value of the line current
(iv) The induced voltage E_O at 900 r/min

(10 marks)

- END OF QUESTIONS -

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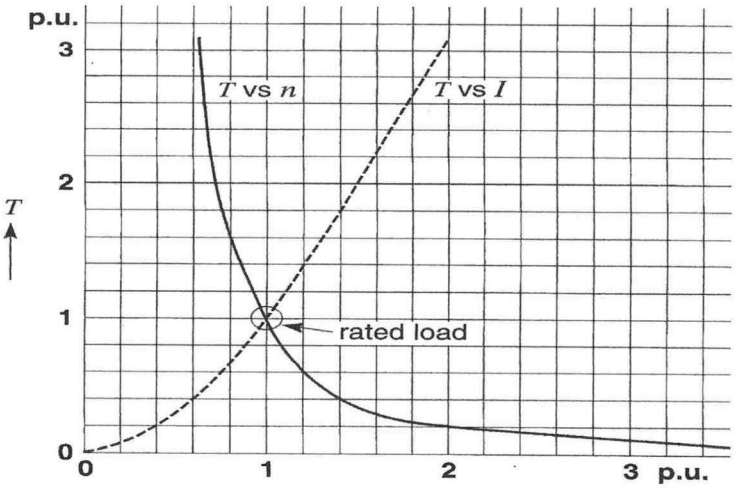

Figure Q1(b)

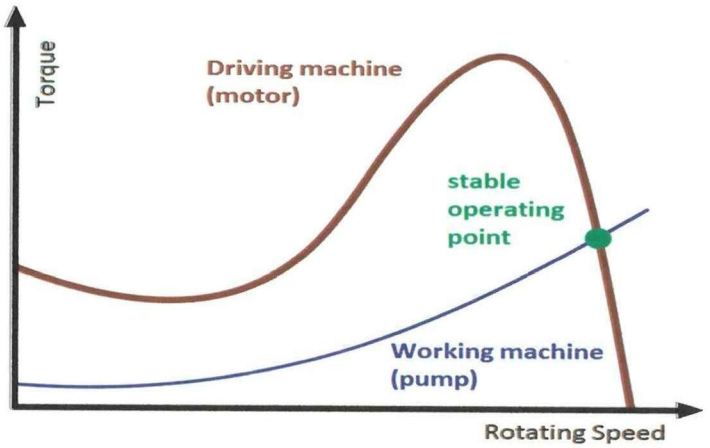

Figure Q2(d)

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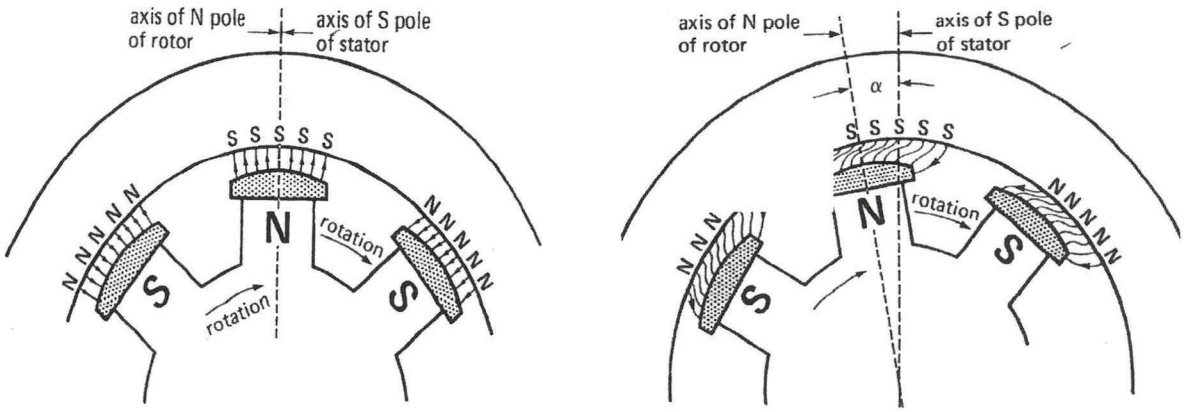

(a) No- load condition (b) Loaded condition

Figure Q3(b)

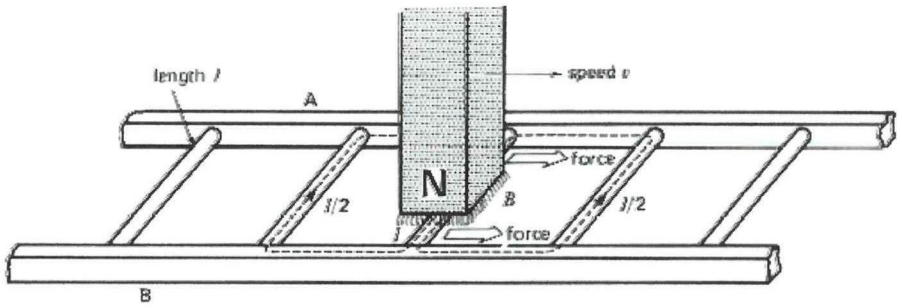

Figure Q4(a)

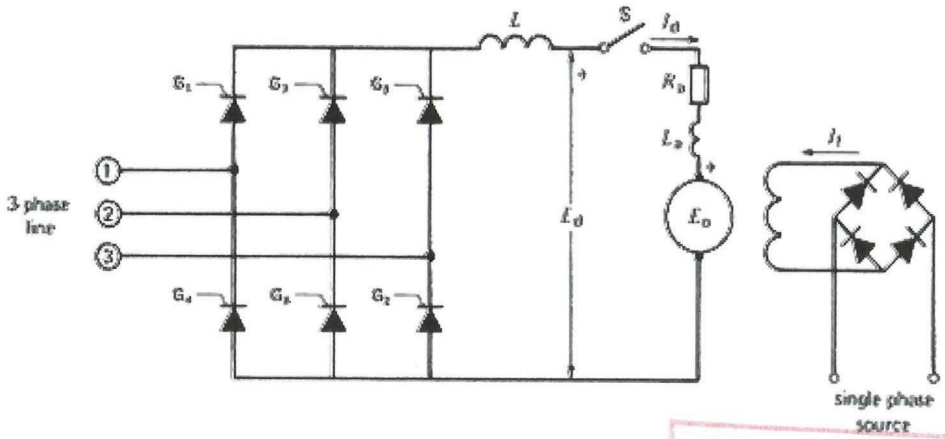

Figure Q5(d)