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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
(TAKE HOME)  
SEMESTER II  
SESSION 2019/2020**

**COURSE : ELECTRICAL MACHINES**  
**COURSE CODE : BEJ 20403**  
**PROGRAMME CODE : BEJ**  
**EXAMINATION DATE : JULY 2020**  
**DURATION : 3 HOURS**  
**INSTRUCTION : ANSWER ALL QUESTIONS  
OPEN BOOK EXAMINATION**

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

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- Q1** (a) Describe the main purpose of having more commutators in a Direct Current (DC) machine?  
(4 marks)
- (b) Using an appropriate diagram from a specific rule, explain how to determine the direction of current flowing in a conductor and the magnetic field.  
(4 marks)
- (c) **Figure Q1(c)** shows a ferromagnetic core whose mean path length is 50 cm. There is a small gap of 0.05 cm in the structure of the otherwise whole core. The cross-sectional area of the core is 15 cm<sup>2</sup>, the relative permeability of the core is 4000, and the coil of wire on the core is 300 turns. Assume that fringing in the air gap increases the effective cross-sectional area of the air gap by 8 percent. Given this information, analyze:
- (i) The total reluctance of the flux path (iron plus air gap).  
(8 marks)
- (ii) The current required to produce a flux density of 1.4 T in the core.  
(2 mark)
- (iii) The current required to produce a flux density of 0.6 T in the air gap.  
(2 marks)
- Q2** (a) What is the difference between DC generator and transformer?  
(4 marks)
- (b) A conductor moves with a velocity of 10 m/s to the right with an angle of 40° relative to the magnetic field as shown in **Figure Q2 (b)**. The flux density is 2.0 T out of the page and the wire is 1.0 m in length.
- (i) What are the magnitude and polarity of the resulting induced voltage?  
(4 marks)
- (ii) Investigate the induced voltage if the conductor is now perpendicularly aligned to the magnetic field and parallel to the direction of vector  $\mathbf{v} \times \mathbf{B}$ .  
(2 marks)
- (iii) Conclude your findings based on the calculated value from **Q2 (b) (i)** and **Q2 (b) (ii)**.  
(4 marks)
- (c) Assuming constant field excitation in a separately excited generator with an armature voltage of 140 V and a speed of 1600 rpm. Calculate the no-load voltage when:
- (i) The speed is increased to 2100 rpm.  
(3 marks)

- (ii) The speed is reduced to 1200 rpm.

(3 marks)

- Q3** (a) List out **four (4)** situations when a DC motor is preferable over Alternative Current (AC) motor.

(8 marks)

- (b) List out **four (4)** types of DC motor.

(4 marks)

- (c) A 120 V shunt motor has an armature whose resistance is 0.22 ohm. Assuming a voltage across the brush contacts is 3 V. Calculate the armature current that will flow:

- (i) when the back EMF is 110 V.

(4 marks)

- (ii) if the motor load is increased, so that the back EMF drops to 106 V.

(4 marks)

- Q4** (a) Define starting torque, peak torque, and stall torque.

(6 marks)

- (b) Why is it important to consider for the stall torque rating when purchasing a DC servo motor?

(2 marks)

- (c) At what condition does an operating DC motor is at its peak efficiency?

(2 marks)

- (d) A 250 V shunt motor has the following parameters:

Armature resistance,  $R_a = 5 \Omega$

Shunt field resistance,  $R_f = 125 \Omega$

Rotational loss,  $P_\mu = 150 \text{ W}$

During full load, the line current is 17.5 A and the motor runs at 1200 rpm. Determine its:

- (i) Developed power.

(4 marks)

- (ii) Output power.

(2 marks)

- (iii) Output torque.

(2 marks)

(iv) Efficiency at full load.

(2 marks)

**Q5** (a) Name the **TWO (2)** types of rotor in AC induction Motor.

(2 marks)

(b) AC Machine can be divided into two types of motor which are Induction Motor and Synchronous Motor. State **FOUR (4)** differences between these machines.

(4 marks)

(c) The alternators in Bhakra hydroelectric power house are driven at 166.7 rpm and have 36 poles on their rotors. Calculate the emf frequency or the electrical frequency,  $f$  generated in the system.

(5 marks)

(d) A three-phase, 6 pole induction motor is supplied from a 50 Hz, 400 V supply. Calculate:

(i) The synchronous speed,  $N_s$ .

(4 marks)

(ii) The speed of the rotor when the slip is 4 percent.

(5 marks)

**-END OF QUESTIONS-**

FINAL EXAMINATION

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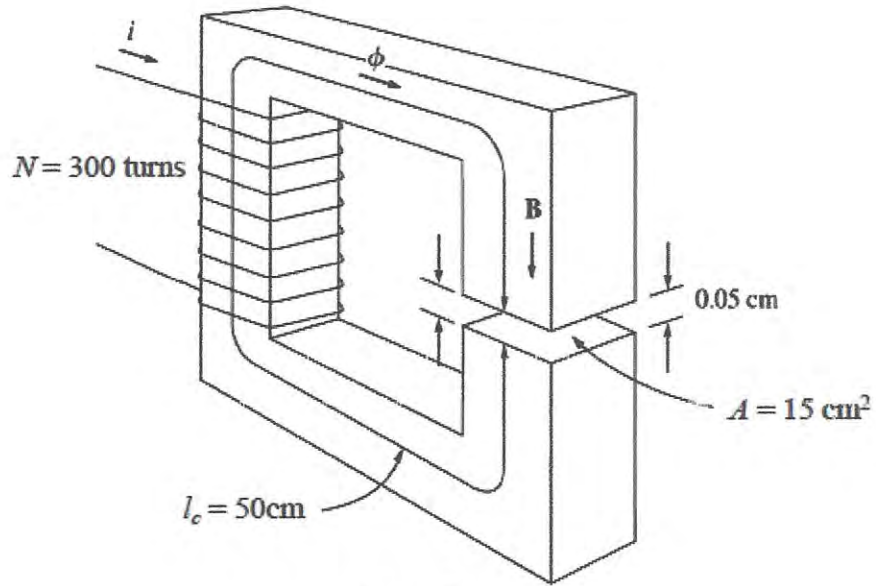


Figure Q1(c)

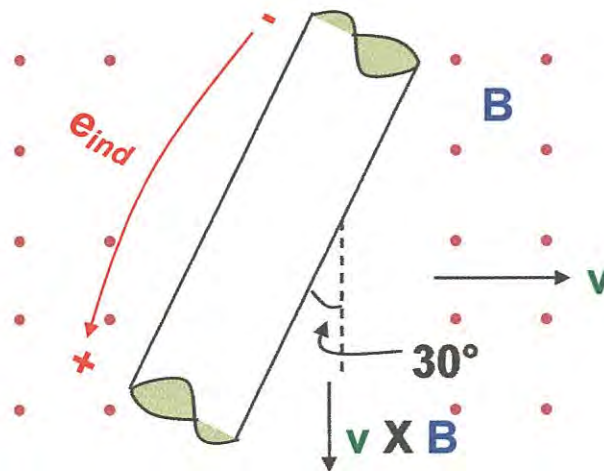


Figure Q2(b)

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