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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023**

COURSE NAME : ELECTRICAL MACHINE
COURSE CODE : BBV 30203
PROGRAMME CODE : BBE
EXAMINATION DATE : JULY/AUGUST 2023
DURATION : 3 HOURS
INSTRUCTION : 1. ANSWER ALL QUESTIONS
2. THIS FINAL EXAMINATION IS CONDUCTED VIA CLOSED BOOK
3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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Q1 (a) State the definition of

- (i) generator
- (ii) motor

(4 marks)

(b) Draw the graph of output voltage versus angle for DC generator (from 0° to 360°). State the angles when the maximum generated voltage is reached. Explain the reason.

(7 marks)

(c) By using suitable Fleming's hand rule, explain the operation of **Figure Q1(c)** in terms of direction of the rotor using the help of label a, b, c and d.

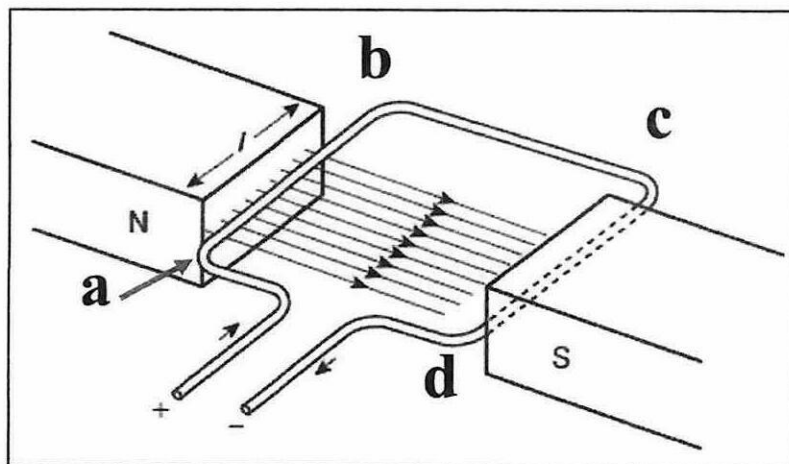


Figure Q1(c)

(5 marks)

(c) A synchronous generator with four (4) poles is attached to prime mover. Determine the speed of generator in order to produce a voltage with frequency of

- (i) 50 Hz

(2 marks)

- (ii) 60 Hz

(2 marks)

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- Q2** (a) Explain the differences between single-phase AC generator and three-phase AC generator based on the basic construction
(2 marks)
- (b) For the large AC three-phase generator, it is more practical to rotate the magnetic field and fix armature winding. By using a suitable diagram, show how the three-phase AC voltage is generated by the large three phase generator.
(8 marks)
- (c) The ACB or negative sequence is produced when the generator rotates clockwise. If the reference phasor is A,
- (i) plot the three-phase voltages in the phasor domain (start with phase A as the reference). State the phasor domain equations
(5 marks)
- (ii) plot the three-phase voltages in the time domain (start with phase A as the reference). State the time domain equations
(5 marks)
- Q3** (a) Induction motor have two main parts namely stator and rotor. Describe the main parts below
- (i) Outer frame
(ii) Stator core
(iii) Stator winding
(3 marks)
- (b) Induction motor is a great invention in history of electrical machine evolusion. Describe three (3) advantages and three (3) disadvantages of inducton motor.
(6 marks)

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(c) There are two types of rotors which are employed in three phase induction motor which are squirrel cage rotor and slip ring rotor.

(i) Sketch the squirrel cage rotor.

(2 marks)

(ii) Give two (2) reasons why the rotor slots are not parallel to the shaft.

(2 marks)

(c) Sketch the power losses in induction motor starting from stator input to output power.

(5 marks)

(e) List two (2) types of single-phase induction motor.

(2 marks)

Q4 (a) Explain the concept of slip in induction motor with the help of appropriate formula regarding percentage of slip.

(2 marks)

(b) A three-phase 40 KW, eight (8)-pole induction motor is connected to 415 V 50 Hz supply. In full-load condition, the efficiency is 85%, 0.8 lagging power factor, and slip at 3 percent (3 %). Determine the

(i) rotor speed.

(2 marks)

(ii) rotor frequency.

(2 marks)

(iii) torque of the shaft.

(2 marks)

(iv) phase current and line current if stator is connected in delta connection.

(2 marks)

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- (c) The power supplied to a three-phase induction motor is 40 kW and the stator losses are 1200 W. If the slip is 4%, determine
- (i) the rotor copper loss (4 marks)
 - (ii) the total mechanical power developed by the rotor (2 marks)
 - (iii) the output power of the motor if friction and windage losses are 750 W (2 marks)
 - (iv) the efficiency of the motor, neglecting rotor copper loss (2 marks)

Q5 (a) List three (3) causes of three phase motor fail to operate. (3 marks)

(b) **Table Q5 (i)** and **Q5 (ii)** shows the results obtained from experiment of connection and starting for universal motor.

Table Q5 (i) AC Connection and starting experiment results for Universal Motor

n/(1/min)	3500	3250	3000	2750	2500	2250	2000
I/A	0.87	1.02	1.23	1.49	1.82	2.17	2.55
M/Nm	0.29	0.37	0.47	0.62	0.8	1	1.22

Table Q5 (ii) DC Connection and starting experiment results for Universal Motor

n/(1/min)	3500	3250	3000	2750	2500	2250	2000
I/A	2	2.13	2.29	2.47	2.64	2.84	3
M/Nm	0.55	0.6	0.66	0.73	0.78	0.85	0.89

- (i) State the exact type of the motor. (1 marks)

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- (ii) From the **Table Q5 (i)** and **Q5 (ii)**, explain the load characteristics for AC and DC connection for the universal motor?
(3 marks)
- (c) A 200V DC shunt motor draws 10A at 1600 rpm. The armature resistance is 0.1 Ω field winding resistance is 440 Ω .
- (i) Calculate the torque.
(6 marks)
- (ii) Calculate the speed and line current at a torque of 20 Nm (if field current is constant).
(6 marks)
- (iii) Make a conclusion regarding the characteristics of shunt wound motor for torque – speed characteristics from the calculation
(1 mark)

- END OF QUESTIONS -

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