Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	ELECTRICAL POWER & MACHINE
COURSE CODE	:	BDJ 20502
PROGRAMME CODE	:	BDJ
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	2 HOURS 30 MINUTES

INSTRUCTIONS

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 **FOUR (4)** PAGES

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Q1 (a) (i) Give a brief definition of power factor and state the relation of current-voltage characteristic in inductive and capacitive circuit.

(3 marks)

(ii) Sketch and label both inductive and capacitive power triangle diagram.

(4 marks)

(b) A single phase motor connected to 400 V, 50 Hz supply takes 35.8 A at power factor of 0.75 lagging. A capacitance is connected in parallel with the motor to increase the power factor. Determine the capacitance required to raise the power factor to 0.95 lagging.

(8 marks)

(c) A 3-phase, 5 kW induction motor has a power factor of 0.75 lagging. A bank of capacitors is connected in delta across the supply terminals and power factor raised to 0.9 lagging. Propose the kVAR rating of the capacitors connected in each phase.

(6 marks)

(d) Explain **TWO (2)** demerits of an electrical system with low power factor.

(4 marks)

Q2 (a) Explain briefly **FOUR (4)** general principles of operation of electrical machines.

(4 marks)

(b) An iron ring with mean diameter of 30 cm is wounded with 300 turns of coil. Examine the magnetic field strength if the voltage supply and coil resistance are 230 V and 10 Ω, respectively.

(5 marks)

(c) A ferromagnetic core in **Figure Q2(c)** has number of turn of coil wrapped around the left side of 300 turns. The depth of the core, the relative permeability, μ_r of the core and the permeability of free space, μ_0 are 12 cm, 2500 and $4\pi \times 10^{-7}$, respectively.

(i) Sketch the equivalent magnetic circuit of the core.

(2 marks)

(ii) Calculate the flux produced by 5 A current.

(5 marks)

(d) **Figure Q2(d)** illustrates a simplified DC motor with 60 number of turns. The cross-sectional area and the relative permeability of the motor are 16 cm^2 and 2600, respectively. The fringing in the air gap increases the effective cross-sectional area of the air gap by 6 %. Examine the resulting magnetic flux density in the air gap if the current supply is 6 A.

(9 marks)

Q3 (a) Explain **THREE (3)** types of DC motor construction. Sketch and label the current flow for each of the DC motor construction.

(9 marks)

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(b) Sketch and label the power flow diagram of a DC motor.

(3 marks)

(c) A shunt motor delivers 195 A at a terminal of 450 V. The armature resistance and shunt field resistance are 0.02 Ω and 50 Ω respectively. The iron and friction losses are equal to 950 W and the other losses are neglected.

(i) Calculate the developed power.

(4 marks)

(ii) Solve the output power delivered to the load.

(2 marks)

(iii) Solve the output torque.

(2 marks)

(iv) If an application required a generator with an efficiency of above 98%, evaluate whether this motor is capable to fulfill the requirement. Support your answer with a clear mathematical solution.

(5 marks)

Q4 (a) Examine in detail **TWO (2)** types of rotor construction in an AC induction motor.

(6 marks)

(b) With the aid of a diagram, differentiate **FOUR (4)** basic type of torques during operation of an AC induction motor.

(8 marks)

(c) A 3ϕ, 12 hp, 450 V, four-pole, 50 Hz, 1428 rpm AC induction motor delivers full output power to a load connected to its shaft. The windage and friction loss of the motor is 730 W. Determine:

(i) the mechanical power input.

(1 mark)

(ii) the power transmitted to the rotor.

(2 marks)

(iii) the rotor copper loss.

(1 mark)

(iv) the efficiency of the motor.

(2 marks)

(v) new motor efficiency if the speed of the induction motor is reduced to 35% of its synchronous speed.

(5 marks)

-END OF QUESTIONS-

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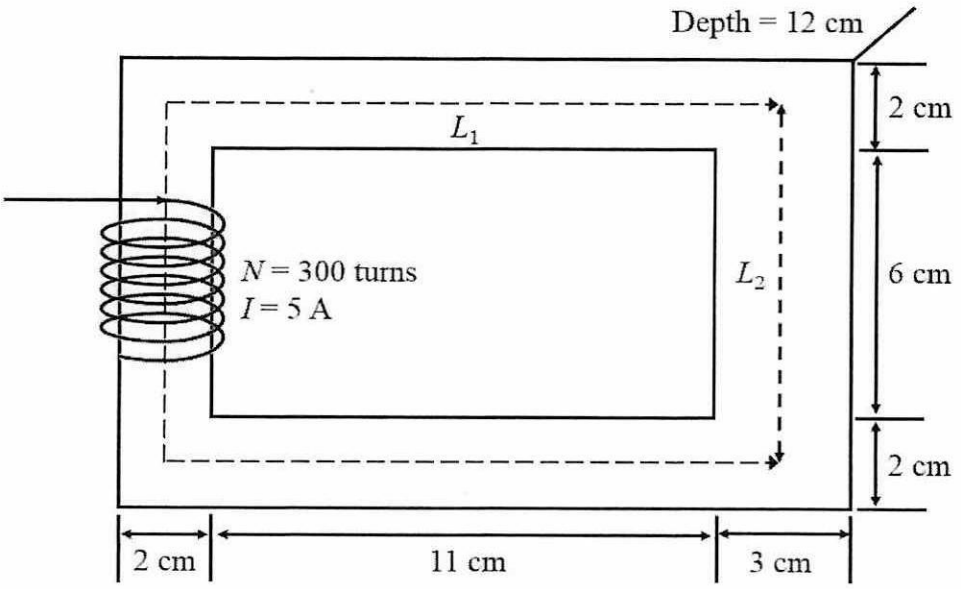

Figure Q2(c)

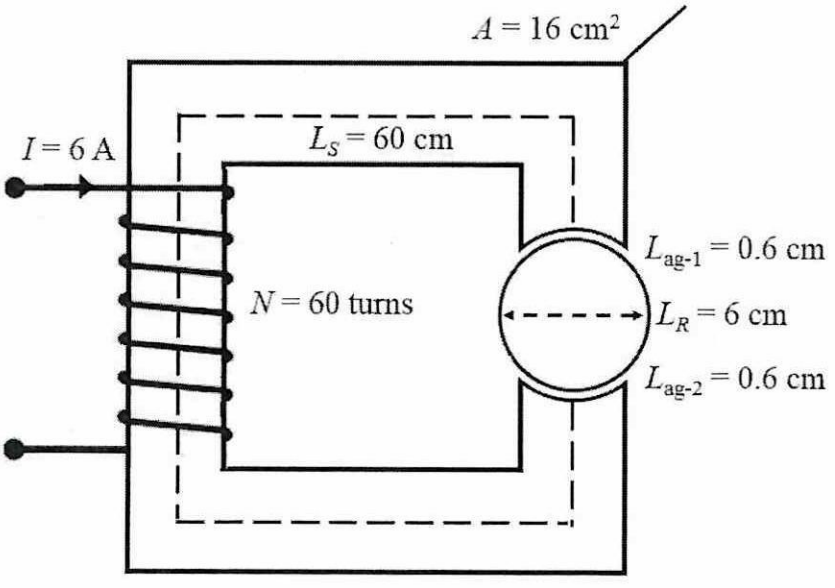

Figure Q2(d)

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