Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	ELECTRICAL MACHINES
COURSE CODE	:	BEV 20803
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWERS **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 **FIVE (5)** PAGES

Q1 (a) **Figure Q1(a)** depicts a ferromagnetic core with depth of 5 cm. The rest of dimensions of the core are as shown in the figure. Assume that the relative permeability of the core is 1200.

(i) Calculate the value of the current that will produce a flux of 0.005 Wb.

(6 marks)

(ii) Illustrate the equivalent magnetic circuit of the ferromagnetic core showing all possible reluctances.

(2 marks)

(iii) Examine the flux density at the top of the core.

(2 marks)

(iv) Examine the flux density at the right side of the core.

(2 marks)

(b) Explain **two (2)** importance of transformer in daily life.

(2 marks)

(c) A single phase 15000 VA, 7.2/0.24 kV distribution transformer posses impedance which referred to the primary of 50 + j100 Ω. The excitation branch consist of core loss resistance, R_C and magnetizing reactance, X_M referred to the high voltage side are 350 kΩ and 70 kΩ, respectively. The primary voltage of the transformer is 7200 V and the load impedance Z_L of 3 + j2 Ω is connected to its low voltage side.

(i) Describe the equivalent circuit of the transformer.

(2 marks)

(ii) Determine the secondary current, secondary voltage, actual secondary voltage and voltage regulation of the transformer.

(6 marks)

(iii) Predict the output power of the transformer if the efficiency is 95% and total power losses are 300 W.

(3 marks)

Q2 (a) List down the power losses in an induction motor

(6 marks)

(b) A 3-phase, 400 V, 50 Hz, squirrel-cage induction motor draws a current of 28.5 A. The total active power, P is given by 17.38 kW when operating at full load. The corresponding speed is accurately measured during running and is fixed to be 738 rpm. The possible synchronous speeds of the given squirrel cage motor are 650 rpm, 750 rpm and 900 rpm. The stator is connected in Y connection and resistance between two stator terminal is 0.12 ohm. The total iron losses and mechanical losses (friction and windage) are 173 W and 88 W respectively.

(i) Determine the power factor at full load, PF

(4 marks)

(ii) Determine the stator copper loss.

(2 marks)

(iii) Determine the active power supplied to the rotor.

(2 marks)

(iv) Find the total I^2R losses in the rotor, P_{RCL}

(3 marks)

(v) Calculate the power converted from electrical to mechanical, P_{CONV}

(2 marks)

(vi) Calculate the output power, P_{out}

(2 marks)

(vii) Classify the induced torque.

(2 marks)

(viii) Figure out the induction motor efficiency

(2 marks)

Q3 (a) By using simple words, explain briefly the operation of a synchronous generator.

(3 marks)

(b) Suggest a type of rotor which is more suitable for a gas turbine generator with a minimum number of poles is 2.

(2 marks)

(c) Electric energy usage for a Y-connected, 50 Hz synchronous motor at chips factory in Sri Gading, Batu Pahat was 260 V, 60 A at unity power factor. The synchronous motor has a synchronous reactance of 8mH and negligible armature resistance. The synchronous motor is working in a linear open-circuit characteristic with the field current flowing under these conditions is 1.8 A.

(i) Calculate the torque angle (δ), of the synchronous motor.

(8 marks)

(ii) Calculate and suggest the required field current, if the synchronous motor operates at 0.75 PF leading and find a new torque angle of the motor.

(12 marks)

Q4 (a) List down types of DC Motor

(3 marks)

(b) A ventilating fan in a poultry farm is driven by a 240 V, 15 kW series DC motor and runs at 1000 rpm at full load. The total armature circuit resistance is 0.5 Ω. The efficiency of the motor is 85%. Assume flux is proportional to the field current. If the current taken by the motor reduces by 50% of the full load value,

(i) Analyse the motor speed.

(6 marks)

(ii) Evaluate the percentage change in torque.

(3 marks)

(c) An 8poles, 360 kW, 240 V, separately excited DC generator is suggested to deliver the rated load at the rated voltage in a factory. The rated speed of the generator is 500rpm. The generator has the following details:

$R_a = 0.05\ \Omega$ $R_F = 20\ \Omega$ $V_F = 100$ V
$N_F = 400$ turns per pole $P_{rot} + P_{core} = 10$ kW

(i) Determine the induced EMF at full load.

(5 marks)

(ii) Identify the power developed.

(2 marks)

(iii) Discover the torque developed.

(4 marks)

(iv) Find out the applied torque.

(2 marks)

-END OF QUESTIONS –

FINAL EXAMINATION

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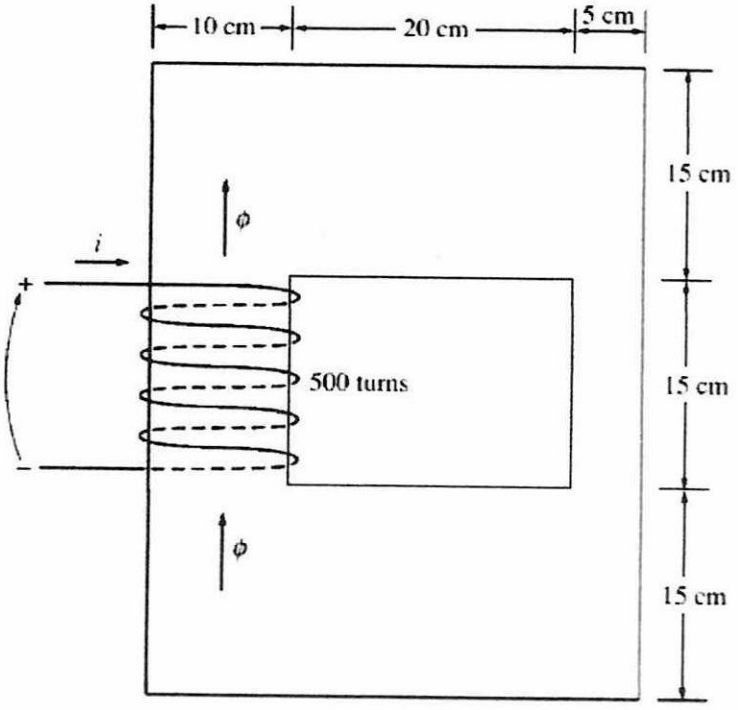

Figure Q1(a)

Formula

$$P_{SCL} = 3I^2R$$

$$P_{AG} = P_{IN} - P_{iron\ loss} - P_{SCL}$$

$$P_{RCL} = sP_{AG}$$

$$P_{CONV} = P_{AG} - P_{RCL}$$

$$P_{CONV} = P_{AG}(1-s)$$

$$P_{CONV} = \frac{P_{RCL}(1-s)}{s}$$

$$P_{out} = P_{CONV} - P_{F\&W} - P_{stray}$$

$$\tau_{ind} = \frac{P_{AG}}{\omega_{sync}}$$