The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

044

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX4307 Electrical Machines and Drives**
Academic Year	:	2021/2022
Date	:	19th of February 2023
Time	:	09.30-12.30
Duration	:	**3 hours**

General Instructions

1. Read all instructions carefully before answering the questions
2. This question paper consists of **Seven (7)** questions in Six (7) pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (**CBT**).
6. The symbols used in this paper have their usual meanings.
7. Clearly state any assumptions that you may make.
8. Answers should be in clear handwriting.
9. Do not use red color pen.
10. You are not allowed to use a programmable calculator.

Question 01

a. Define the following laws of electromagnetic induction. [6 marks]

   i.) Faraday's Laws
   ii.) Lenz's Law
   iii.) Fleming's Rules

b. A cylindrical bar magnet is kept along the axis of a circular solenoid. If the magnet is rotated about its axis, determine whether an electric current is induced in the coil.

[2 marks]

c. Explain self induced e.m.f and mutual induced e.m.f with the help of appropriate diagrams and equations. [4 marks]

d. A closed coil of 40 turns and an area of 200 cm^2 is rotated in a magnetic field of flux density 2 Wb m^{-2}. The coil rotates in the magnetic field, making an angle of 60° to the field at a time of 0.2 sec. Find the magnitude of the emf induced in the coil due to its rotation. [8 marks]

Question 02

a. Define the function of a transformer. [2 marks]

b. A 5 kVA, 2200/220V, single-phase transformer has the following parameters;

$$H.V\ side \quad r_1 = 3.4\Omega \qquad X_1 = 7.2\Omega$$
$$L.V\ side \quad r_2 = 0.028\Omega \qquad X_2 = 0.06\Omega$$

i.) A transformer is made to deliver a rated current at 0.8 lagging power factor to a load connected on the L.V. side. If the load voltage is 220V, calculate the terminal voltage on the H.V. side (Draw the equivalent circuit referred to L.V side). [8 marks]

ii.) Repeat part (a) for a load of 0.8 power factor leading. [4 marks]

iii.) For a core loss of 30 Watts at rated voltage and frequency, find the efficiency under the condition of parts (i) and (ii). [6 marks]

Question 03

a. Define and Briefly explain the operation principle of DC generator and DC motor. [4 marks]

b. What are the available armature winding types, and explain them briefly. (Compare their deferences) [4 marks]

c. Depending on the interconnection between the armature and the field circuit D.C.Motors are classified into 3 types. State and explain the different types of DC motors available. [6 marks]

d. A 4 pole dc series motor has wave-connected winding with 600 conductors. The total resistance of the armature and the field coil of this motor is 0.8 Ohm. When this is fed from a 250 V dc source and supplies a load of 10 kW, it takes 50 A current with a flux per pole of 3 mWb. For these operating conditions, calculate the developed torque on the motor shaft. (Figure 01) [6 marks]

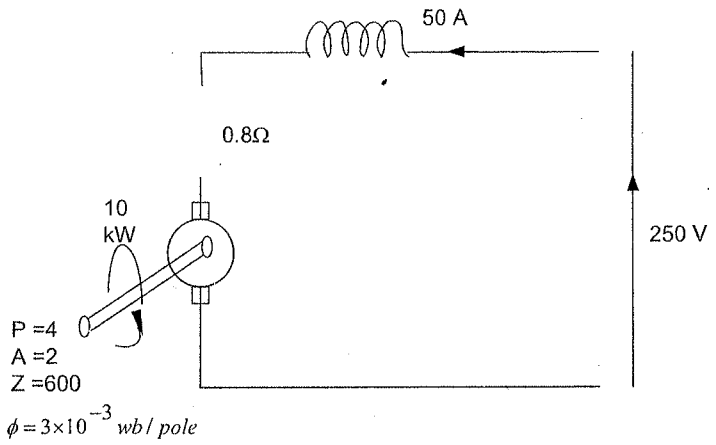

Figure 01

Question 04

a. Briefly explain two important features of a DC generator. [2 marks]

b. State six parameters to be considered in order to define the characteristics of a DC generator. [6 marks]

c. The DC generators are classified according to the way they produce field flux. State and explain two different types of DC generators. [4 marks]

d. A 4 pole generator with wave wound armature has 51 slots, each having 24 conductors. The flux per pole is 0.01 Weber. [8 marks]

i.) At what speed must the armature rotate to give an induced emf of 220 V?

ii.) What will be the voltage developed if the winding is a lap and the armature rotates at the same speed?

Question 05

a. Explain the reason for the 3 - phase induction motors are self-starting while the single-phase motors are not self-starting. [2 marks]

b. Briefly explain the following parts related to an induction motor. [4 marks]

i.) Stator

ii.) Rotor

c. There are basically classified into two types based on rotor construction. State them and give one advantage of each type. [4 marks]

d. A 20 kW, 6 pole, 400V, 50 Hz 3pahse induction motor has a full load slip of 0.02. If the torque lost in mechanical (friction & windage) losses is equivalent to 20 Nm, Compute:

i.) The mechanical torque available on the shaft

ii.) Electrical torque available on the shaft

iii.) Rotor ohmic loss (P_{cu})

iv.) Air gap power (P_{ag})

v.) Motor input power

vi.) Motor input efficiency

Assume that the total stator loss is 900 watts. [12 marks]

Question 06

a. Briefly explain the construction of a synchronous generator. [4 marks]

b. Describe the following terms used to describe the windings on a synchronous machine.

i.) Field winding

ii.) Armature winding

[4 marks]

c. Compare and contrast DC motors vs. AC Motors [4 marks]

d. A 4 pole synchronous generator driven at 1500 rpm feeds a 6 pole induction motor which is loaded to run at the slip of 5%. What is the motor speed? [8 marks]

Question 07

a. Compare and contrast stepper motors vs. DC motors. [6 marks]

b. State 4 control parameters influence the speed and torque of induction motors.

[4 marks]

c. A stepper motor has 51 rotor poles and 45 stator poles. The winding inductance and resistance are 2mH and 15Ω, respectively. The rated current is 0.3 A. Determine:

i.) What is the step size in degrees?

ii.) If the motor is stepping at 6000 Hz, what is the synchronous speed in rpm?

iii.) Achieve rated pull-out torque requires a stepping period of 5-time constants. What is the motor's synchronous speed at rated torque, in rpm?

[10 marks]

END