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

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	: 2020/21
Date	: 5th February 2022
Time	: 0930hr – 1230hr
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Six (6)** 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. Answers should be in clear handwriting.
7. Do not use **Red** color pen.

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c) Briefly describe the principle of operation of a synchronous motor.

[4 Marks]

d) A 480V, 6 poles synchronous motor draws 50A from the line at **unity** power factor and **full** load. Assuming that the motor is lossless, answer the following questions:

i. Explain what must be done to change the power factor to **0.8 Leading** using a phasor diagram.

[5 Marks]

ii. Determine the magnitude of the line current if the power factor is adjusted to 0.8 leading.

[5 Marks]

Question 05

a) State four reasons why the 3-phase Induction motor is the most commonly used AC motor in the industry.

[4 Marks]

b) A 4 pole, 3-phase Induction motor operates from a supply whose frequency is 50Hz. Calculate:

i. The speed at which magnetic field of the stator is rotating

[2 Marks]

ii. The speed of the rotor when the slip is 0.04

[2 Marks]

iii. The frequency of the rotor currents when the slip is 0.03

[2 Marks]

iv. The frequency of the rotor currents at standstill

[2 Marks]

c) A 6 pole, 3-phase Induction motor runs at a speed of 960rpm and the shaft torque is 135.7Nm. Calculate the Rotor Copper Loss if the friction and windage losses amount to 150W. The frequency of supply is 50Hz.

[8 Marks]

Question 06

a) Explain three functions of the power modulator in an electric drive system.

[4 Marks]

b) Describe how a variable speed drive (VSD) is used to control the speed of an induction motor.

[4 Marks]

c) A DC series motor is fed from a 600V source through a chopper. The DC motor has the following parameters. The armature resistance is equal to 0.04Ω, field resistance is equal to 0.06Ω and constant $\mathbf{K_v = 4x10^{-3}\ Nm/A^2}$. The average armature current of 300A is ripple free. For a chopper duty cycle of 60%, Determine:

i. Input power drawn from the source

[3 Marks]

ii. Motor Speed

[5 Marks]

iii. Motor Torque

[4 Marks]

(Hint: For DC Series motor, $\varphi = I_a$)

Question 07

a) State the disadvantages of square wave inverter in Induction motor drive.

[4 Marks]

b) An inverter supplies to a 4 pole, 3-phase cage rotor induction motor rated at 240V, 50Hz. Determine the output (voltage and frequency) required for the inverter to gain a motor speed of 1000rpm.

[4 Marks]

c) Distinguish the advantages of a Brushless DC motor over a typical DC motor.

[4 Marks]

d) A 2 pole, 3-phase alternator running at 3000rpm has 42 slots with 2 conductors/slot. Calculate the flux/pole required to generate a line voltage of 2300V.
(Assume: $\mathbf{k_d = 0.952}$ **and** $\mathbf{k_c = 0.956}$)

[8 Marks]

Question 08

a) State three main differences between a Unipolar driver and a Bipolar driver.

[3 Marks]

b) State two characteristics that the Switched reluctance drive have in common with an induction motor.

[2 Marks]

c) List four main advantages of using DC Servo motors.

[4 Marks]

d) Explain why the squirrel cage induction motor is considered a **constant-speed** motor.
[4 Marks]

e) If the EMF in the stator of an 8 pole induction motor has a frequency of 50Hz and that in the rotor is 1.5Hz, Calculate the speed in which the motor is running and its Slip.
[7 Marks]

END