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 Drivers**
Academic Year	: 2019/20
Date	: 16th October 2020
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 **Five (5)** 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 hand writing.
7. Do not use Red color pen.

Question 01

a) List down three advantages of a DC shunt motor.

[3 Marks]

b) A 440V, shunt motor has armature resistance of 0.7 Ω and field resistance of 250 Ω. Determine the back emf when giving an output of 8.53 kW at 80 percent efficiency.

[5 Marks]

c) A 220 V shunt motor has armature and field resistance of 0.2 Ω and 220 Ω respectively. The motor is driving a constant load torque and running at 1000 rpm drawing 10 A current from the supply. Calculate the new speed and armature current if an external armature resistance of value 5 Ω is inserted in the armature circuit. Neglect armature reaction and saturation.

[12 Marks]

Question 02

a) State three differences between Step-up transformer and Step-down transformer.

[3 Marks]

b) List down five characteristics of an Ideal transformer.

[3 Marks]

c) An ideal transformer is rated at 2400/120-V, 9.6kVA and has 75 turns on the secondary side. Calculate:

i. Turns ratio.

[1 Mark]

ii. The number of turns on the secondary side.

[1 Mark]

iii. The current ratings for the primary and secondary windings.

[1 Mark]

d) A 60Hz, 50kVA, 2400/240V single phase ideal transformer has 50 turns on the secondary winding. The transformer is connected to the generator that has the impedance of **j9.5**. Find the following:

i. Primary and secondary currents.

[3 Marks]

ii. Number of turns on the primary.

[3 Marks]

iii. Voltage at the generator.

[5 Marks]

Question 03

a) List the types of Synchronous Machines.

[2 Marks]

b) Draw the round rotor synchronous generator equivalent circuit and clearly indicate the parameters.

[3 Marks]

c) A 3-phase synchronous generator produces an open-circuit line voltage of 6928V when the do exciting current is 50A. The AC terminals are then short-circuited, and the three-line currents are found to be 800A.

i. Calculate the synchronous reactance per phase.

[2 Marks]

ii. Calculate the terminal voltage if three 12Ω resistors are connected in wye across the terminals.

[4 Marks]

d) A 3-phase Y-connected alternator is rated at 1600 kVA, 13500 V. The armature resistance and synchronous reactance are 1.5Ω and 30Ω respectively. Calculate the percentage voltage regulation for a load of 1280 kW at 0.8 leading power factor.

[9 Marks]

Question 04

a) State the two basic essential parts of an electrical generator.

[2 Marks]

b) Briefly describe what is a prime mover for an electrical generator and give some examples for prime movers.

[3 Marks]

c) A series motor has an armature resistance of 0.3Ω and a series field resistance of 0.5Ω. It is connected to a 240V supply and at a particular load runs at 1500 r.p.m. when drawing 15A from the supply.

i. Determine the back e.m.f. at this load.

[3 Marks]

ii. Calculate the speed of motor when the load is changed such that the current is increased to 30 A. (Assume that this case a **doubling of flux**).

[5 Marks]

d) On full-load a 300V series motor takes 90A and runs at 900 r.p.m the armature resistance is 0.1Ω and the series winding resistance is 50mΩ. Determine the speed when developing full load torque but with a 0.2Ω diverter in parallel with the field winding. (assume that the flux is proportional to the field current).

[7 Marks]

Question 05

a) List the disadvantages of AC generator.

[3 Marks]

b) State the three main types of stepper motors.

[3 Marks]

c) An AC generator is connected across the terminals of a 2.85μF capacitor. If the capacitive reactance is 500Ω, what is the frequency of the AC generator?

[3 Marks]

d) 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.

i. What is the step size, in degrees?

[3 Marks]

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

[3 Marks]

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

[5 Marks]

Question 06

a) List the three main types of Electric drive systems.

[3 Marks]

b) State the three important reasons for using Variable Speed Drives.

[5 Marks]

c) Dynamic braking is employed with a 4 pole DC separately excited motor driving a load. The armature is wave wound and has 251 conductors. The moment of inertia of the motor is 150kgm^2 and that of the load is 200 kgm^2. The resistance of the armature circuit is 0.05Ω. Assuming a constant flux per pole of 0.02Wb, Calculate the time taken to reduce the speed from 100 rpm to 1 rpm. The maximum permissible armature current is 300A and may be assumed to be constant until the entire external armature circuit resistance is cut off.

[12 Marks]

Question 07

a) State the two types of AC motors, and explain the differences between these two types of motors.

[4 Marks]

b) State the disadvantages of Square wave inverter in Induction motor drive.

[4 Marks]

c) A 3-pole, 6-phase, 60Hz Induction motor is operating at rated load. The nameplate rated slip is 2.5%. Calculate the rotor speed.

[5 Marks]

d) The Synchronous speed of a 3-phase induction motor is 25 rev/s and the frequency of the supply to the stator is 50Hz. Calculate the equivalent number of pairs of poles of the motor.

[7 Marks]

Question 08

a) List the two main differences between AC Servo motors and DC Servo motors.

[4 Marks]

b) State four main advantages of using DC servo motors.

[4 Marks]

c) A motor equipped with a flywheel has to supply a load torque of 600Nm for 10sec, followed by a no-load period long enough for the flywheel to regain its full speed. It is desired to limit the motor torque to 450Nm. The no load speed of the motor is 600rpm and has 8% slip at a torque of 450Nm. Calculate the moment of inertia of the motor plus flywheel. (The speed torque characteristic of the motor can be assumed to be a straight line in the region of interest).

[12 marks]

END