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

030

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: **DMX4410 Electrical and Pneumatic Machines**
Academic Year	: 2021/22
Date	: 03rd February 2023
Time	: 1330hr – 1630hr
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 (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.

Question 01

a) State the definition of Electromagnetism. List three uses of electromagnets.

[4 Marks]

b) State the EMF equation of a DC machine and define the notations.

[3 Marks]

c) Draw the circuit diagram of a Self-excited Shunt wound DC generator and briefly explain its principle of operation.

[4 Marks]

d) A six-pole generator has a flux per pole of 0.08Wb. The armature is Lap wound with 288 conductors and the EMF generated is 480V. Find the speed of the armature.

[4 Marks]

e) A 4-pole 500V, 25kW, long-shunt compound generator delivers full load at the rated voltage. Calculate the EMF generated if the armature resistance is 0.03Ω, series field resistance is 0.04Ω and shunt field resistance is 200Ω. Consider the contact drop per brush as 0.9V.

[5 Marks]

Question 02

a) State the three types of DC motors as per the winding type used.

[3 Marks]

b) A 4-pole, wave-wound DC motor has 48 armature slots each containing 4 conductors. The flux per pole is 58.7mWb and armature resistance is 0.2Ω. When connected to a 400V supply, the motor runs at a speed of 1050rpm.
Calculate the:

i. Back EMF developed by the motor.

[4 Marks]

ii. Armature current

[4 Marks]

c) Consider the 15kW, 100V DC series generator with armature resistance of 0.85Ω and a series field resistance of 0.15Ω given below in **Figure Q02(c).** Assume that the generator is delivering rated current at rated speed.

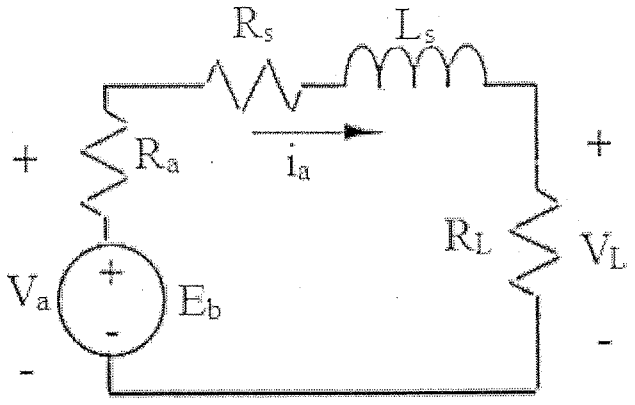

Figure Q02(c)

Calculate:

i. The armature current $\mathbf{i_a}$

[3 Marks]

ii. The generated voltage $\mathbf{E_b}$

[3 Marks]

d) A DC shunt motor takes 22A at 220V and has an armature resistance of 0.5Ω and shunt field resistance of 110Ω. If the total mechanical and magnetic losses together are 160W, Calculate the Field Copper loss.

[3 Marks]

Question 03

a) State three main differences between an AC generator and DC generator.

[3 Marks]

b) A 6 pole, 3 phase, star connected alternator has 90 slots and 8 conductors per slot and rotates at 1000rpm. The flux per pole is 50 mWb. Find the induced EMF across its lines. (Consider the winding factor as 0.97 and $k_c = 1$).

[5 Marks]

c) Sketch the diagrams of the salient pole and cylindrical pole synchronous generators and state three main differences between them.

[5 Marks]

d) A 500 kVA, 1100V, 50Hz, Y-connected, 3 phase synchronous generator has armature resistance per phase of 0.1Ω and synchronous reactance per phase of 1.5Ω. Calculate its voltage regulation for unity power factor and sketch the phasor diagram for this condition.

[7 Marks]

Question 04

a) The 3-phase induction motor is the most commonly used AC motor in the industry. State three main advantages of this motor.

[3 Marks]

b) A 12 pole, 3 phase induction motor is fed from a 100Hz supply. If the frequency of the rotor EMF at full load is 5Hz, calculate the full-load speed and percentage slip.

[5 Marks]

c) The power input to the rotor of a 440V, 50Hz, 3 phase, 12 pole induction motor is 75W. The rotor EMF has a frequency of 2Hz.
Calculate:

i. Percentage Slip

[3 Marks]

ii. Rotor speed

[3 Marks]

iii. Rotor copper loss

[3 Marks]

iv. Mechanical power developed.

[3 Marks]

Question 05

a) List and briefly explain the three major types of pressure control valves used in pneumatic systems.

[6 marks]

b) State the factors that influence the size of an air receiver.

[3 marks]

c) Draw and label the following pressure control methods, and briefly explain the operation of each.

i. Receiver pressure control using compressor outlet valve.

ii. Receiver pressure control using compressor inlet valve.

[11 marks]

Question 06

a) Brief the classification of pneumatic actuators.

[2 marks]

b) Explain the operation of following valves with clear conventional symbol.

i. Check Valve
ii. Shuttle Valve
iii. Quick exhaust valve

[6 marks]

c) Draw clear timing diagrams of "on delay" and "off delay" timers.

[4 marks]

d) A double acting cylinder **1A** shown in **Figure Q6(d)** is to extend when a push button is operated. Upon release of the push button the cylinder is to retract.

i. Draw and describe the operation of the circuit for the problem with designate the valves and include the numbering system for the connection.

[5 Marks]

ii. What happens to the cylinder, if the push button is pressed for a very short period, and is then immediately released?

[3 marks]

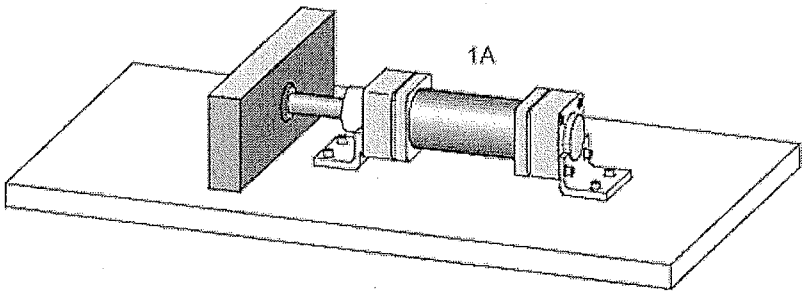

Figure Q6(d)

Question 07

a) List down four advantages of proximity sensors.

[4 marks]

b) Briefly explain the operation of an indirect control of a double-acting cylinder using a 5/2-way double solenoid at the piston extend position using circuit diagrams.

[6 Marks]

c) Describe the sequence of operation for the following electro-pneumatic control system given below in **Figure Q07(c).**

Note - The three-wire reed switch (**1B1 &1B2**) consists of three reed contacts. One is connected to positive terminal of electric supply. Second one is connected to negative terminal of the electric supply and third one is connected to the signal output.

[10 marks]

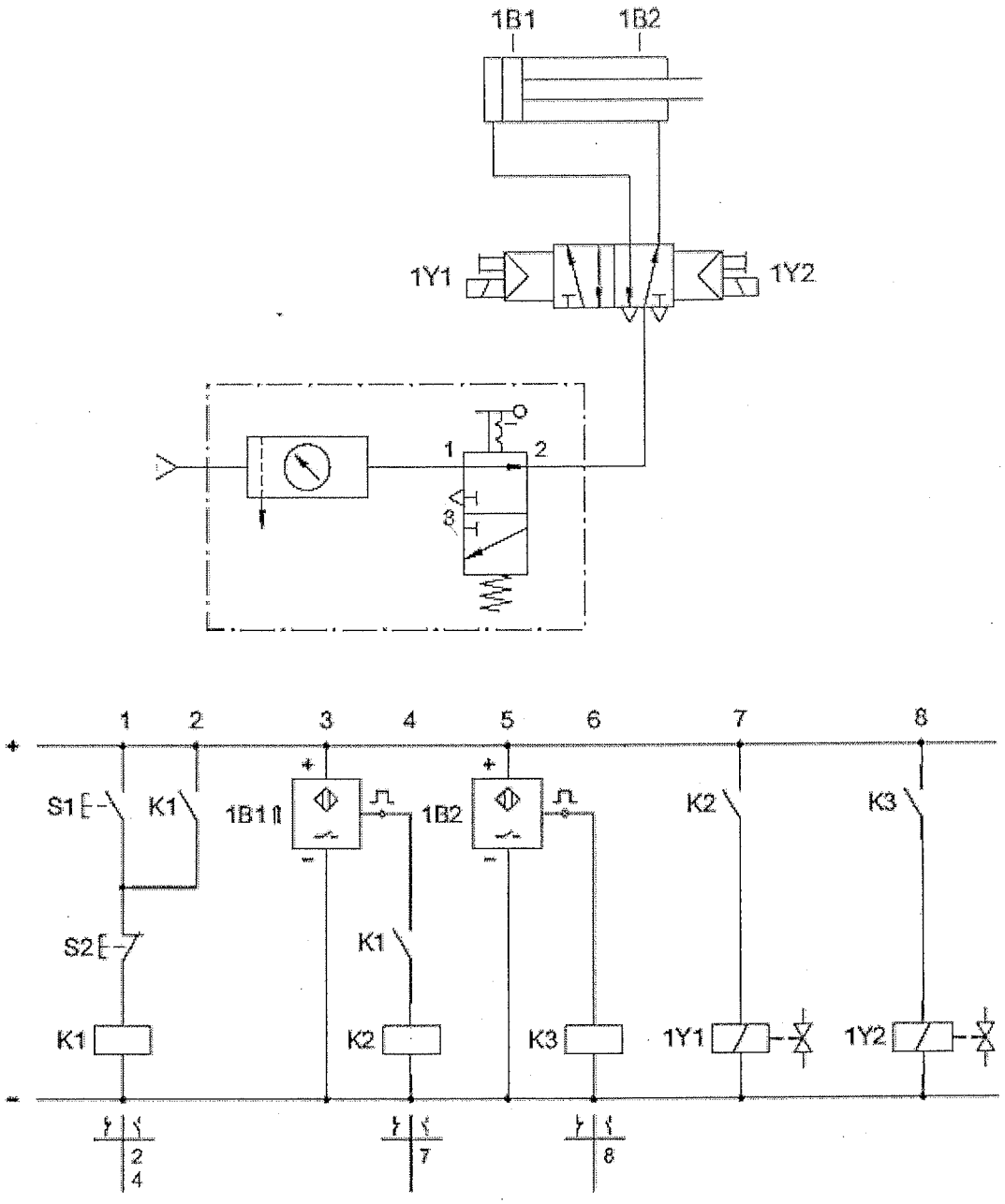

Figure Q07(c)

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