Course:	HD in Artificial Intelligence and Robotics
Course code:	EG114728
Module:	Industrial Automation
Module code:	MBS4521

Official Use

Lab 2:
Electro-pneumatic Circuits I

Student Name:	Cheung Tsz Chun Noddy
Student number:	2207 1174
Names of other members:	1. Lai Ho 2. Lai Ka Ming 3. Lui Shing Tak
Date received: Due date:	25/2 21/4
Signature:	Cheung Tsz Chun Noddy

Notes to Students:
1. Maximum of 4 members per group
2. Submit this lab sheet in pen writing
3. Individual submission required
4. Use spaces given for each part
5. Glue print out in specified spaces
6. Due date will be given in lab session
7. A maximum of 5% will be deducted for untidiness
8. Late submission will normally not be accepted

Objective

After completion of this lab, students should be able to:

1. familiarize electrical component (e.g. electromechanical relay, timer relay, solenoid valves) and build simple electro-pneumatic circuits with given electrical ladder diagram.
2. build simple electro-pneumatic circuits with given electrical ladder diagram.
3. understand the importance of **sequential control** and be cognizant of the sequence of the operation of cylinders in both the electro- pneumatic circuit and simulate simple circuits using specific software (e.g. ***Automation Studio***).

Introduction

After learning how pneumatic circuits work in previous lab 1, you should be aware that pure pneumatic circuits have limitations. For more precise control and with many more electronic sensors, pneumatic system preform better and the design can be more dedicated.

Sequence control systems are operated by turning on and off switches, motors, valves and other devices in response to operating conditions as a function of time. A specific sequence is designed for a specific task. With the replacement of pneumatic valves to electronic devices, electric wires are much easier to route and tidier. The basic input devices used are limit switches, pushbutton switches, photoelectric switch, control relay etc., and the output devices are valves, solenoid, stepping motor, speaker, control relays, timer relays etc. The control of the pneumatic cylinders using solenoid operated directional control valves require the understanding of electrical ladder diagram.

Again, with the help of computer simulation software, electro-pneumatic circuits can be simulated before building it to test for functionality.

In this laboratory session, students are required to work as a group of 4 members (maximum). Each group is required to build their own circuit and run the computer simulation. Each member is required to print out the result and paste it onto his/her own lab sheet. Every student should hand in his/her own lab sheet one week after the lab session.

Apparatus

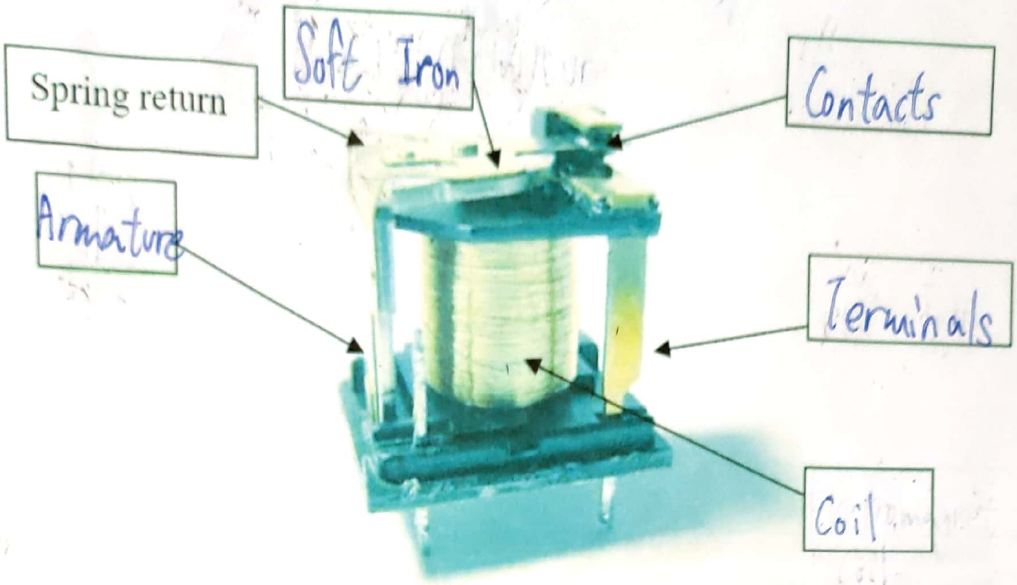
1. Pneumatic design and simulation software (Automation Studio)
2. Personal computers
2. Electro-pneumatic components, relay box and accessories
3. Pneumatic training board

Procedures

Part A – Electro-pneumatic component Basic (20%)

Relay circuit:
Relays are used in many modern control systems, as it is an electrical switch with a high current rating that is indirectly operated by a low control current. See Fig.1 for a typical electro-mechanical relay construction.

A1. Fill the names of the relay parts:

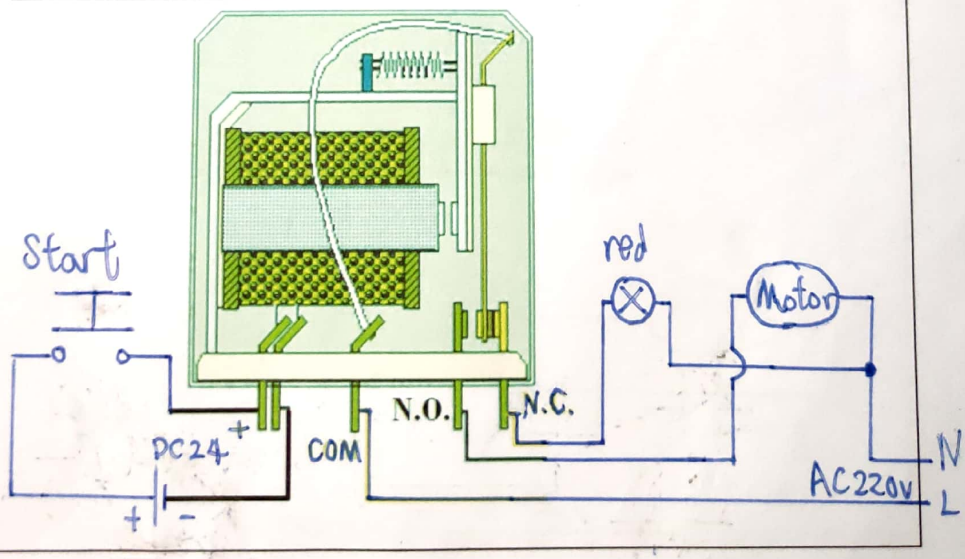


A2. P35

Given an electromechanical relay (EMR) with one NO and one NC contact which can hndle a continuous load of 220Va.c. and 3 ampere. The relay coil requires 24Vd.c. to operate.

Requirement:
Connect a momentary switch to energize the coil.
If the coil is ~~not energized~~, a RED light is on.
If the coil is energized, a 220Va.c. motor will rotate (RED light will be off).

Complete the **hardwiring circuit** below:



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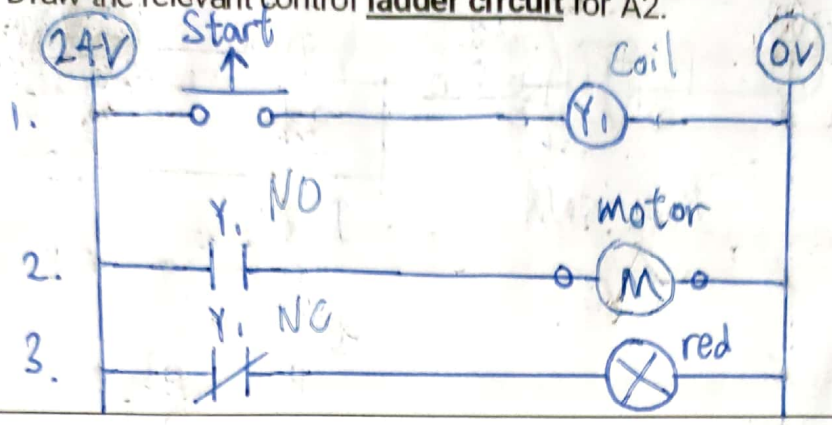
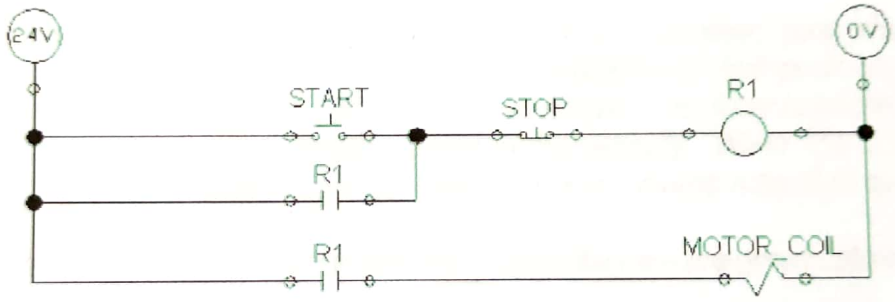
A3. Draw the relevant control **ladder circuit** for A2.

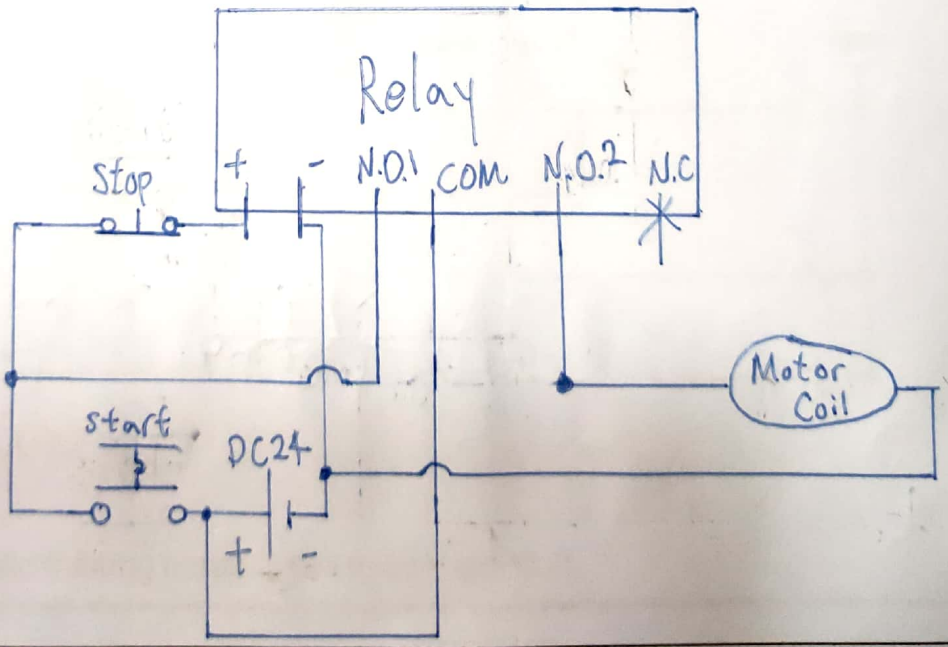


PS1

A4. In the circuits A2 and A3, the motor can only rotate when the pushbutton is pressed. Although a bistable switch can be used to latch the output, a method of circuit wiring named ***self-holding circuit*** can be used with a momentary switch. However, a N.C. switch must be added to reset the circuit. The circuit is shown below:



According to the above ladder circuit, sketch the hardwire circuit with relevant component as in A2.



Part B – Relay Circuit Practice (10 %)

B1. Use the pneumatic training board to construct the circuit in **A4**.

Official use:
Satisfactory / Minor assistance required / Major assistance required / Incomplete

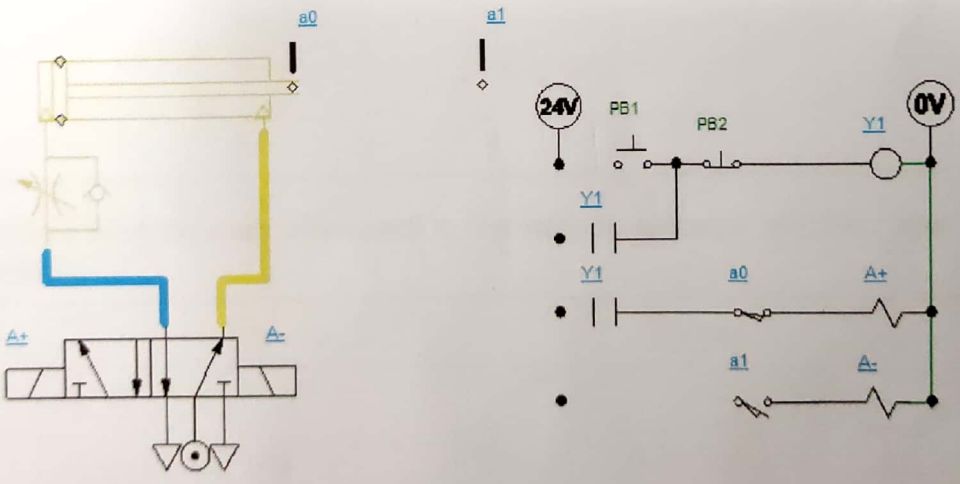
Part C – Software Simulation and Circuit design and built (40 %)

C1. Simulating a double acting cylinder performing an oscillatory movement

A double acting cylinder is controlled by a 5/2 double solenoid actuated directional control valve with two limit switches as position sensors. A timer relay is used to delay the cylinder after it reaches its maximum extended position.

Actuation requirement: *When a START button (NO) is pressed (one shot with spring return), the cylinder will extend to its limit position, stay still for 5 seconds, and then it will return to its fully retracted position. The cycle repeats again automatically. When the STOP button is pressed, the cylinder will stop running after that cycle.*

The electro-pneumatic sub-circuit and the ladder diagram are given below:



Use the pneumatic training board to construct the circuit.

Official use:
Satisfactory / Minor assistance required / Major assistance required / Incomplete

C2. **Sequential Control of TWO double acting cylinders**

Students are required to design an electro-pneumatic circuit by CASCADE method with the following sequences:

Start, A+, B+, B-, A-

The operation is a ***single cycle*** design, i.e. operate one complete cycle by pressing the START button (NO momentary) once. The extension speed of each cylinder should be adjustable. The system could be operated again if the START button is pressed again.

Pneumatic and electrical components:

- Double acting cylinders
- 5/2 double solenoid actuated directional control valves
- Limit switches (or reed switches) (NO and NC)
- Variable NR throttle valves
- Electro-mechanical relays (4P2T)
- 24Vd.c. power supply
- Pushbuttons (NO and NC)
- Connection cables

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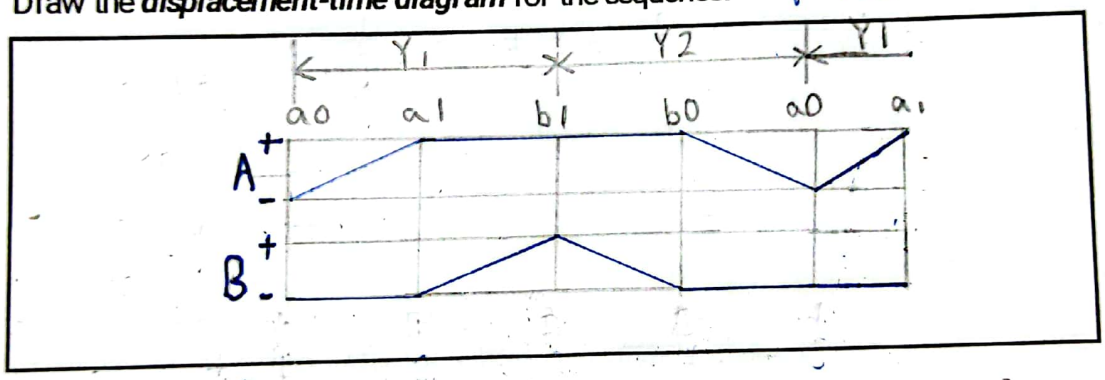
C3. Draw the ***displacement-time diagram*** for the sequence.



C4. Draw a ***block diagram (flowchart)*** to represent the sequence with the correct actuating signals..

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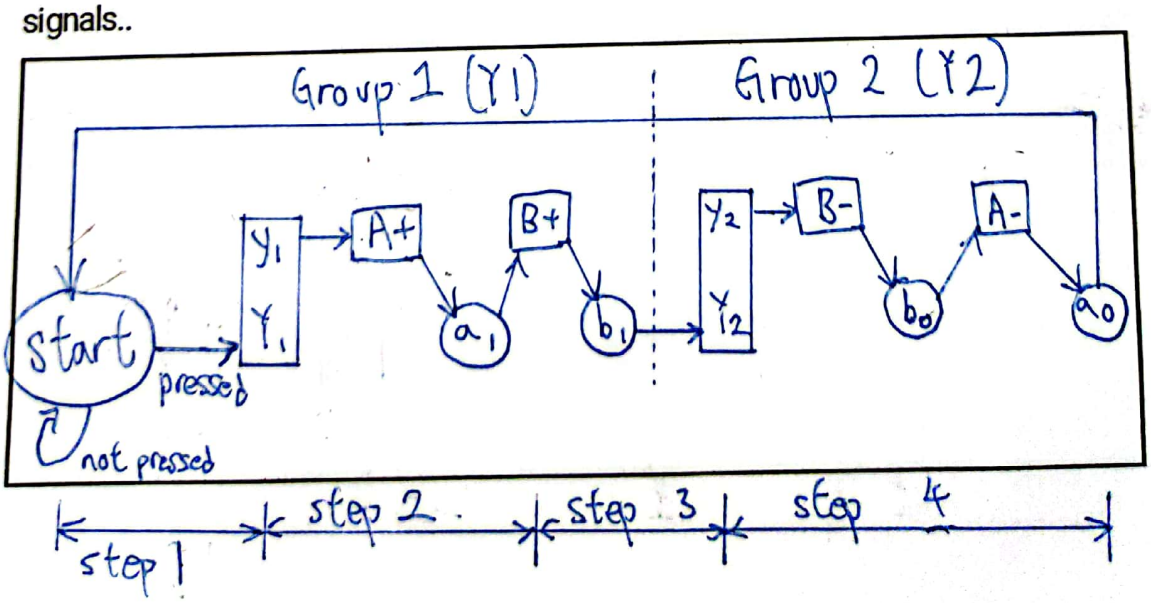

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C5. Using electro-pneumatic software to design and draw the circuits (both pneumatic sub-circuit and electrical ladder) using **cascade method**.

Graph is in the last page

C6. Connect your circuit using electro-pneumatic training board with hardwired logic components.

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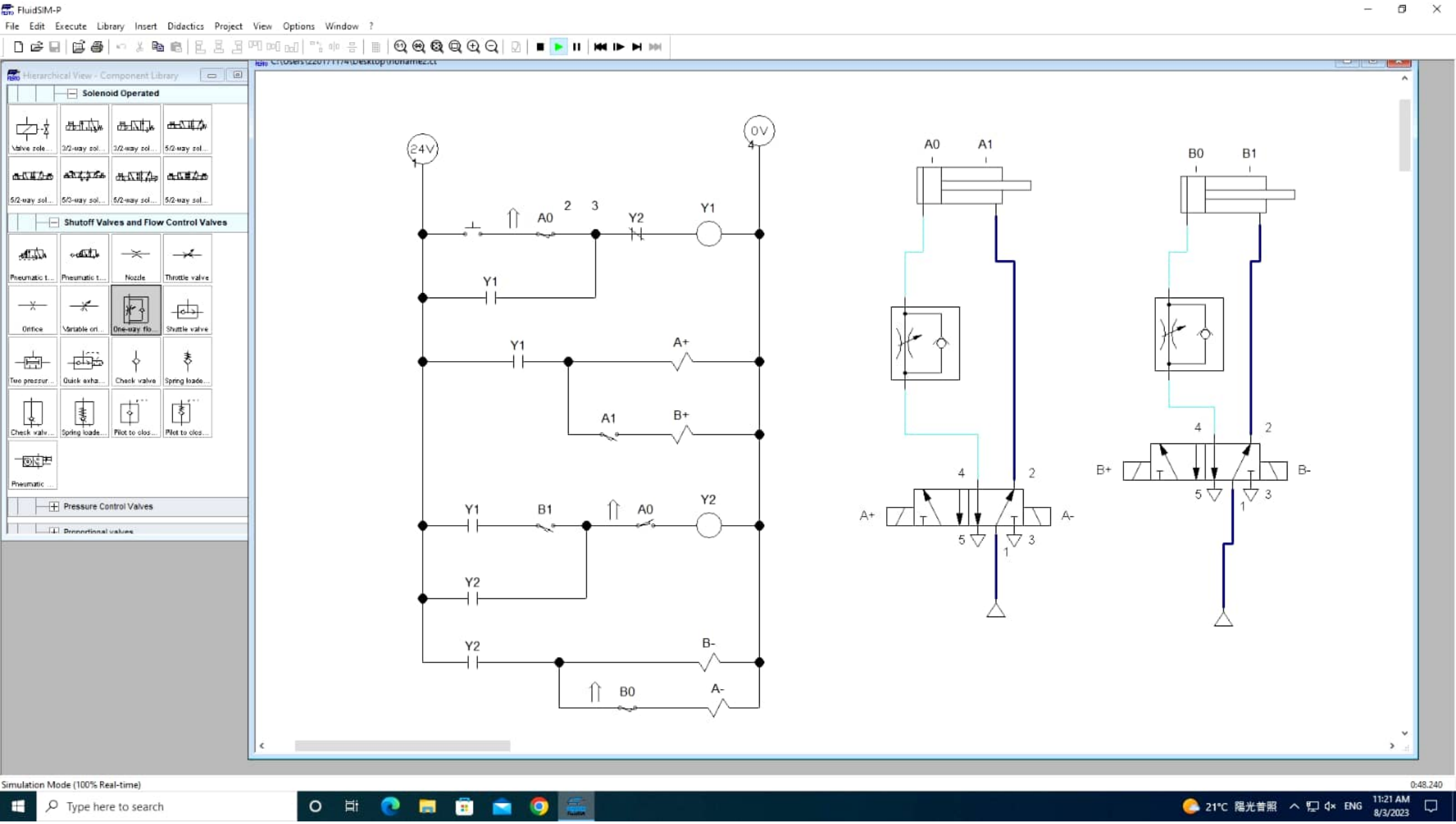
Satisfactory / Minor assistance required / Major assistance required / Incomplete


FluidSIM-P
File Edit Execute Library Insert Didactics Project View Options Window ?
Hierarchical View - Component Library
Solenoid Operated
Shutoff Valves and Flow Control Valves
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Part D – Observation and Discussion (30 %)

D1. State any FOUR functions of electro-mechanical relay.

1 Switching function - switch circuit on/off
2 Amplification function - amplify control signal
3 Isolation function - provide isolation between different parts of circuit
4 Protection function - protect system from demage due to overload

D2. Discuss the advantages and limitations of using electro-mechanical relay. Suggest a replacement component that can overcome the limitations you have stated.

Advantages: High switching capacity, low power consumption, Simple operation, High reliability.
limations: limited lifespan, slow switching speed, Audible noise, limited switching freqvency. One replacement component can overcome the limitations is the solid-state relay. It have a longer lifespan and don't produce audible noise.

D3. Discuss the advantages of electro-pneumatic systems over pneumatic systems.

1. Precise control: Electro-pneumatic systems offer more precise control over actuator movement than pneumatic system
2. Programmability: Electro-pneumatic systems can be easily programmed using a PLC or other control system.
3. Lower energy consumption: Electro-pneumatic systems can be more energy-efficient than pneumatic systems. This is because electro-pneumatic systems use electric signals to control, allowing more precise control and reduced the wastage of compressed air.

- End -