<table>
<thead>
<tr>
<th>Fakulti: FAKULTI KEJURUTERAAN ELEKTRIK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nama Matapelajaran: MAKMAL KEJ. ELEKTRIK</td>
<td>Semakan : 3</td>
</tr>
<tr>
<td>Kod Matapelajaran : SKEM 3742</td>
<td>Tarikh Keluaran : 2013</td>
</tr>
<tr>
<td></td>
<td>Pindaan Terakhir : 2017</td>
</tr>
<tr>
<td></td>
<td>No. Prosedur :</td>
</tr>
</tbody>
</table>

Fakulti: FAKULTI KEJURUTERAAN ELEKTRIK

UNIVERSITI TEKNOLOGI MALAYSIA

KAMPUS SKUDAI

JOHOR

MECHATRONICS LABORATORY

ELECTRO-HYDRAULIC &

ELECTRO-PNEUMATIC (TASK and PROBLEMS)

<table>
<thead>
<tr>
<th>Disediakan oleh</th>
<th>Disahkan oleh Ketua Jabatan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nama : Dr. Mohd Ariffanan Mohd Basri</td>
<td>Nama : Assoc Prof. Ir. Dr. Norhaliza Abdul Wahab</td>
</tr>
<tr>
<td>: Dr. Salinda Buyamin</td>
<td></td>
</tr>
<tr>
<td>: Assoc. Prof. Dr. Mohamad Noh Ahmad</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tandatangan</th>
<th>Tandatangan</th>
</tr>
</thead>
<tbody>
<tr>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cop</th>
<th>Cop</th>
</tr>
</thead>
<tbody>
<tr>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tarikh</th>
<th>Tarikh</th>
</tr>
</thead>
<tbody>
<tr>
<td>:</td>
<td>:</td>
</tr>
</tbody>
</table>
1. **Electro-Hydraulic**

**Task 1: Actuation of the 4/2 Way Directional Control Valve.**

**Practice Objective**
After working through this practice, students are expected to be able to understand the basic operation of the electro-hydraulic control circuits using a double-acting cylinder.

**Procedure**
1. Connect the hydraulic circuit according to Figure 1.1(a).
2. Connect the electric circuit as shown in Figure 1.1(b).
3. Validate the hydraulic circuit and the electric circuit for any misconnection.
4. Turn the hydraulic power unit ON. Adjust the pressure to 25 to 35 MPa at the pressure-limiting valve.
5. Turn the DC Power Supply ON. Set the voltage to be 24V.
6. Turn S0 ON.
7. Press and hold S1, verify if the piston rod continue to extend to its maximum limit.
8. Release S1; verify if the piston rod retracts.
9. Once you finish the practice, turn OFF of the Hydraulic Power Unit and DC Power Supply.

![Figure 1.1: Circuit drawing of hydraulic and electrical circuits for Task 1](image)

**Assignment:**
Based on your observation, fill in Table 1.1.

<table>
<thead>
<tr>
<th>S1</th>
<th>Double-Acting Cylinder (Extend/Retract)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressed</td>
<td></td>
</tr>
<tr>
<td>Released</td>
<td></td>
</tr>
</tbody>
</table>

Based on your understanding, describes the expected result if the connection A and B to cylinder is swapped.

~End~

Practice Objective
After working through this practice, students are expected to understand the self-holding concept in the electro-hydraulic control system.

Procedure
1. Connect the hydraulic circuit according to Figure 1.2(a).
2. Connect the electric circuit as shown in Figure 1.2(b).
3. Validate the hydraulic circuit and the electric circuit for any misconnection.
4. Turn the hydraulic power unit ON. Adjust the pressure to 25 to 35 MPa at the pressure-limiting valve.
5. Turn the DC Power Supply ON. Set the voltage to be 24V.
6. Turn S0 ON.
7. Press S1; verify if the piston rod continue to extend to its maximum limit.
8. Press S2; verify if the piston rod retracts.
9. Once you finish the practice, turn OFF of the Hydraulic Power Unit and DC Power Supply.

![Hydraulic and Electrical Circuits](image)

Figure 1.2: Circuit drawing of hydraulic and electrical circuits for Task 2

Assignment
Based on your observation, explain the differences between Task 1 and Task 2, in term of:
1. The operation and function of the electrical circuit.
2. The operation and function of the hydraulic circuit.
Task 3: Implementing Basic Logic Functions in Electro-hydraulic Circuit.

**Practice Objective**
After working through this practice, students are expected to be able to relate the installation of parallel and serial electric circuit of with the basic logic functions (OR/AND/NOT).

**Assignment**
By using hydraulic circuit shown in Figure 1.2(a), design electrical circuits to perform the following tasks:

1. Task #1: Cylinder is extended whenever S1 and S2 are pressed.
2. Task #2: Cylinder is extended whenever S1 or S2 are pressed.
3. Task #3: Cylinder is extended whenever S1 is pressed and S2 is not pressed.

For each task (1 to 3), you are required to:

1. Write down the truth table of the operation.
2. Formulate the logic equations based on the truth table.
3. Design the electrical circuit that you have designed.
4. Validate (and record) the experiment observation.
2. Electro-Pneumatic

Task 1: Actuation of the 5/2 Way Directional Control Valve (DCV).

**Practice Objective**
After working through this practice, students are expected to understand the basic operation of the electro-pneumatic control circuit using a double-acting cylinder.

**Procedure**
1. Connect the pneumatic circuit as shown in Figure 2.3(a).
2. Connect the electric circuit as shown in Figure 2.3(b).
3. Validate the pneumatic circuit and electric circuit for any misconnection.
4. Turn the pneumatic power unit ON. Adjust the pressure to 2 to 5 bars at the pressure-limiting valve.
5. Turn the electrical power unit ON.
6. Press S1 and verify if the piston rod of the pneumatic cylinder extends.
7. Press S2 and verify if the piston rod of the pneumatic cylinder retracts.
8. After you complete the experiment, turn OFF of the pneumatic power unit and electric power unit.

![Figure 2.3](image)

(a) Pneumatic Circuit
(b) Electrical Circuit

**Figure 2.3:** Circuit drawing of pneumatic and electrical circuits for Task 1

**Assignment**
Based on your observation, fill Table 2.2.

<table>
<thead>
<tr>
<th>S1</th>
<th>S2</th>
<th>Double-Acting Cylinder (Extend/Retract/No change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not pressed</td>
<td>Not pressed</td>
<td></td>
</tr>
<tr>
<td>Not pressed</td>
<td>Pressed</td>
<td></td>
</tr>
<tr>
<td>Pressed</td>
<td>Not pressed</td>
<td></td>
</tr>
<tr>
<td>Pressed</td>
<td>Pressed</td>
<td></td>
</tr>
</tbody>
</table>

Based on your understanding, describes the expected result if both solenoids (B1 and B2) in Figure 1.3(b) are swapped.

~End~

**Practice Objective**  
After working through this practice, students are expected to understand the self-holding concept in the electro-pneumatic control system.

**Procedure**  
1. Connect the pneumatic circuit and electric circuit as shown in Figure 2.4(a) and (b).
2. Validate the pneumatic circuit and electric circuit for any misconnection.
3. Turn the pneumatic power unit ON. Adjust the pressure to 2 to 5 bars at the pressure-limiting valve.
4. Turn the electrical power unit ON.
5. Press and hold S1. Verify if the piston rod of the pneumatic cylinder extends.
6. Release S1. Verify if the piston rod of the pneumatic cylinder extends.
7. Record your observation.
8. Press the switch S2 and verify if the piston rod of the pneumatic cylinder retracts.
9. Replace the current electric circuit to the electrical circuit shown in Figure 2.5. Repeat procedure #3 to #7. Based on your observation, explain the differences observed between these two electrical circuits.
10. After you complete the experiment, turn OFF of the pneumatic power unit and electrical power unit.

---

**Figure 2.4: Circuit drawing of pneumatic and electrical circuits for Task 2**

---

~End~
Figure 2.5: Self-holding electrical circuit
Task 3: Implementing Basic Logic Functions in Electro-pneumatic Circuit.

**Practice Objective**
After working through this practice, students are expected to be able to relate the installation of parallel and serial electric circuit with the basic logic functions (OR/AND/NOT).

**Assignment**
By using the pneumatic circuit as shown in Figure 2.6, try out different electrical circuits as shown in Figure 2.7(a) to Figure 2.7(e).

![Figure 2.6: Pneumatic circuit for Task 3](image-url)
For each scenario (Figure 2.7(a) to Figure 2.7(c)), you are required to:

1. Write down the truth table of the observed result.
2. Formulate the logic equation based on the truth table.
3. Identify which logic function is used.

Based on what you have learned in the previous section, design an electro-pneumatic circuit that fulfill the following truth table (refer Table 2.3).

<table>
<thead>
<tr>
<th>S1</th>
<th>S2</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Note:
For S1 & S2: 0 = Not press & 1 = Press
For d: 0 = Retract & 1 = Extend

You are required to:

1. Formulate the logic equations based on the truth table.
2. Design the electro-pneumatic circuit you had designed.
3. Validate the design with the experiment observation.
4. Identify which logic function that has the same truth table as Table 2.3.
3. PROBLEMS

3.1. Electro-Hydraulic

Application of Electro-hydraulic in Vehicle Lift

Practice Objective

After working through this practice, students are expected to be able to design and implement an electro-hydraulic circuit which behaves as vehicle lift.

Assignment

A vehicle lift as shown in Figure 3.1 has been widely used in the automobile service centres.

![Vehicle lift diagram](image)

Figure 3.1: Vehicle lift

Design and demonstrate an electro-hydraulic circuit that meets the following requirements:

1. Use a 4/3 single-solenoid spring return control valve to actuate the cylinder.
2. The cylinder should lift the car to half its maximum position when S1 is pressed. The lift will stop after being contact with limit switch.
3. Then, the cylinder should lift the car to its maximum position when S2 is pressed.
4. If the S3 is pressed at any period of time, the cylinder will return to its initial/home position.
5. Incorporates memory circuit for all the pushbuttons (S1, S2 and S3).
6. Include two physical contact switches to detect whether all the car tires are on the platform for safety purposed. Requirement 2 to 4 can only be execute if and only if all the car tires are detected by the contact switches.

In your report, please include (but not limited to) the following information:

1. The truth table of the expected result.
2. The logic equations based on the truth table.
3. The hydraulic and electrical circuits that you had designed.
3.2: Application of Electro-Pneumatic in Box Sorting

**Practice Objective**

After working through this practice, students are expected to design and install an electro-pneumatic circuit using multiple cylinders with sequence motion.

**Assignment**

Figure 3.2 illustrates the application of electro-pneumatic system in a box sorting system. The objective of this assignment is to place the boxes either into container A or B accordingly based on size. You are needed to design an electro-pneumatic circuit for the following requirements:

1. Conveyor belt is used to move the boxes.
2. Cylinder c is used to push the box to the continuously moving conveyor belt.
3. Stop the conveyor belt if the big box is detected on the conveyor belt and use cylinder d to push the big box into container A.
4. The small box will be delivered into container B which located at the end of the conveyor.

Your electro-pneumatic design must fulfill (but not limited to) the following criteria:

1. Use pushbutton S1 and S2 to respectively start and stop the operation of the system.
2. Use the proximity sensors / limit switches to detect the positions of cylinders and to determine the size of boxes.
3. Use two 5/2 ways DCV with spring return.
4. Incorporates memory circuit for the pushbutton.

Once you have completed the design, please demonstrate your result to the facilitator. In your report, please include (but not limited to) the electro-pneumatic circuit you had designed.