| SEKOLAH KEJURUTERAAN ELEKTRIK | | |
|---|---|---|
| Nama Matapelajaran<br><br>Kod Matapelajaran :SKEM 3742 | : MAKMAL KEJURUTERAAN ELEKTRIK | Semakan : 1<br>Tarikh Keluaran : 11 Feb 2020<br>Pindaan Terakhir :<br>No. Prosedur : |

# SKEM 3742

# SCHOOL OF ELECTRICAL ENGINEERING
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# MECHATRONICS LABORATORY

# ELECTRO-HYDRAULIC (TASK and PROBLEMS)

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| Stamp | : | Stamp | : |
| Date | : 11 February 2020 | Date | : 11February 2020 |

**Safety Information for the Project Exercise**

All safety regulations must always be observed before and during execution of the project, to ensure correct operation of the system and to recognize and avoid any hazards presented by machines and the hydraulic system.

The system must always be checked to ensure that all components and assemblies are correctly connected in a functionally safe manner according to the specified exercise setup and that all unused ports are safely closed using suitable plugs. Leak- age oil can drip from open ports onto the floor and present a slipping hazard. When starting the system, hydraulic fluid can escape from open ports in a narrow stream at high pressure, which can cause serious injuries (cutting jet).

**General notes on setup of the hydraulic circuit:**

Always check that all pressure control valves are set to minimum pressure (spring unloaded) and all throttle valves are open before commissioning the hydraulic system, i.e. before switching on the hydraulic pump. All hydraulic accumulators that may be present must first be depressurized. The tank of the hydraulic power unit must also be checked to ensure that it contains the correct amount of hydraulic fluid according to the operating instructions.

When setting up the hydraulic circuit, the hose couplings can be easily plugged onto the coupling plugs when all residual pressure has been removed from the workstation.
The following actions (depending on the exercise setup) are recommended in order to remove all residual pressure from the workstation:

1. Completely depressurize the pressure relief valve (counter clockwise).
2. Open all throttle valves.
3. Actuate the directional valve.
4. Depressurize the pressure reducing valve (clockwise).
5. Hydraulically depressurize the hydraulic accumulator using the handwheel of the unloading device.
6. Move the hydraulic cylinder with load unit to the lower limit stop.

When setting up the hydraulic circuits the components are connected using hydraulic hose lines with quick couplings. You can lightly turn the hose to check that the connection between the hose and the component has latched securely into position. **Never use force!!**

**General notes on working with hydraulic training systems:**

Exercise caution when a system is pressurized and/or electrical voltage is present:

1. Do not release any line connections, ports or components when the exercise setup is under pressure (also check any hydraulic accumulators that may be present)
2. Do not connect or disconnect any electrical systems when the hydraulic power unit and/or the exercise setup is connected to the electrical power supply!
3. Adjusting the settings of pressure relief valves and pressure switches on the exercise setup:

**The workstation may only be operated with a maximum pressure of 60 bar!**

## Task 1: Identification of Hydraulic Components / Assign Symbols

***Practice Objective***

After working through this practice, students are expected to be able to understand the hydraulic components and its symbols.

**Task 1.1**

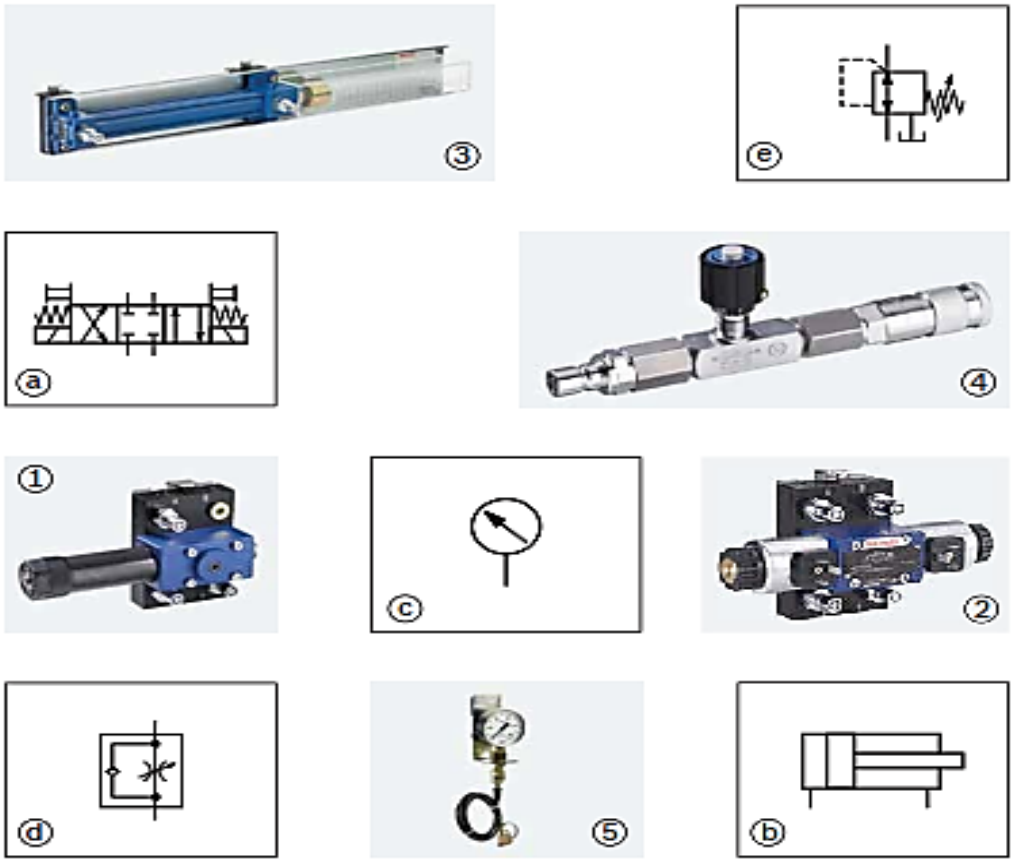



**Figure 1.1: Hydraulic components and symbols used**

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

| Components | Components Number | Symbol Identification Letter |
|---|---|---|
| Differential cylinder | | |
| Throttle/non return valve | | |
| Pressure reducing valve | | |
| Manometer | | |
| Directional control valve (electronically controlled) | | |

**Table 1.1**

## Task 1.2

The item numbers from the parts listed in Table 1.2(a) and 1.2(b) are to be assigned to the corresponding component on the hydraulic circuit diagram in Figure 1.2.

| Item | Quantity | Designation |
|---|---|---|
| 0.10 | 1 | Hydraulic power unit with external gear pump |
| 0.20 | 1 | P/T distributor with integrated pressure relief valve |
| 0.30<br>0.31 | 2 | Hose line |

**Table 1.2 (a)**

| Item | Quantity | Designation | Type | Rexroth material number |
|---|---|---|---|---|
| 1.10 | 1 | Differential cylinder | CD70F25/16-200 | R961009526 |
| 1.20 | 1 | Throttle/non-return valve | DRV06-1-1X/V | R961002495 |
| 1.30 | 1 | Pressure reducing valve | DR6DP1-5X/75 | R961002544 |
| 1.40<br>1.41 | 2 | Manometer 0 to 100 bar | | R961002715 |
| 1.50<br>1.51<br>1.52<br>1.53<br>1.54 | 5 | Hose line 630 mm | ZN10031-08-W00NN-630 | R961002474 |
| 1.60 | 1 | Hose line 630 mm with Minimess port | ZN10031-08-W00MM-630 | R961002481 |
| 1.70 | 1 | 4/3 directional control valve, electrical operation | 4WE6G6X | R961002548 |

**Table 1.2 (b)**

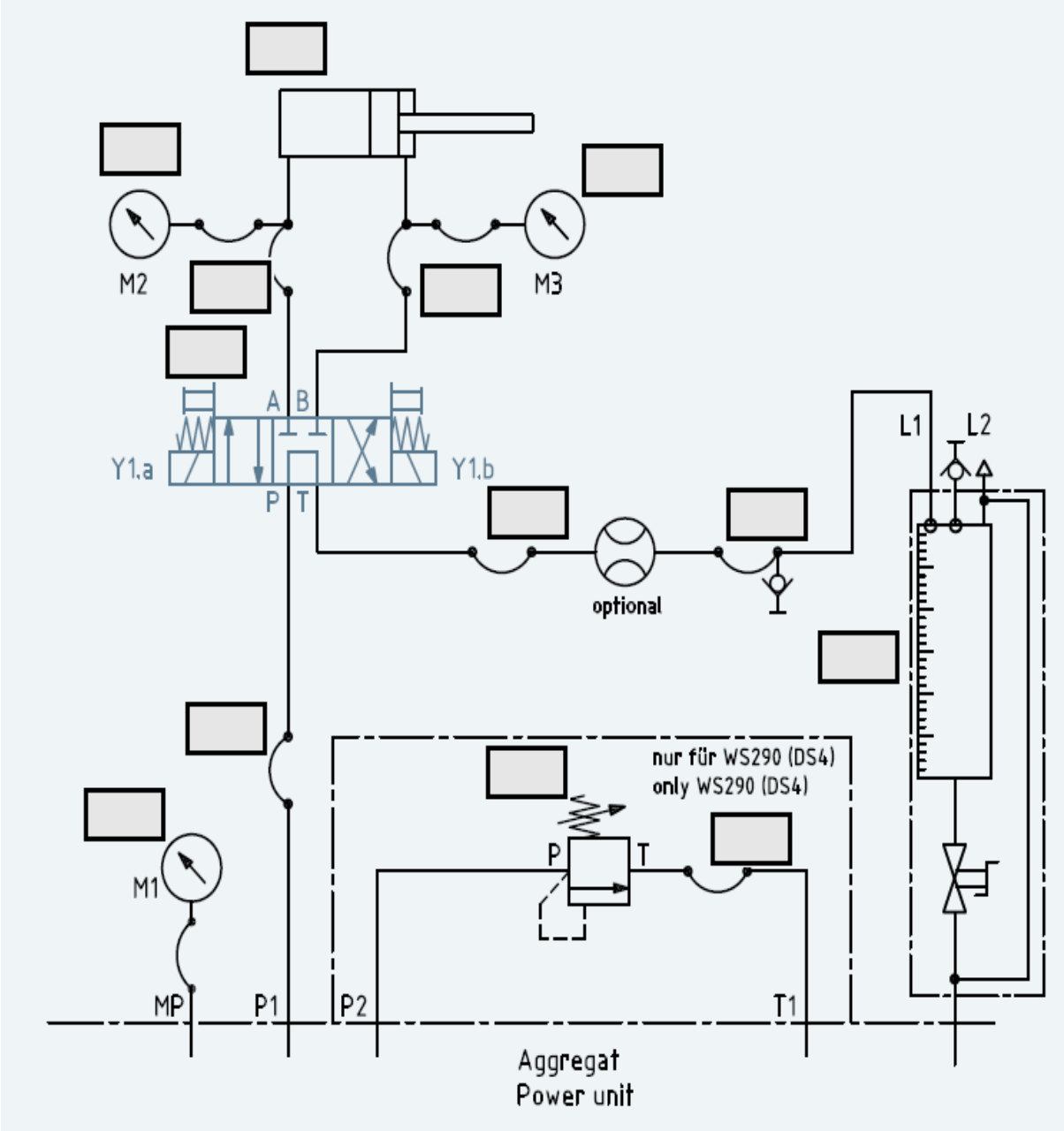



**Figure 2.1: Hydraulic circuit diagram**

**Task 1.3 :**

Graphical representation of the electro-hydraulics valves is shown in Figure 1.3. Identify and assign the symbols for electrical switching elements in Table 1.2(c).

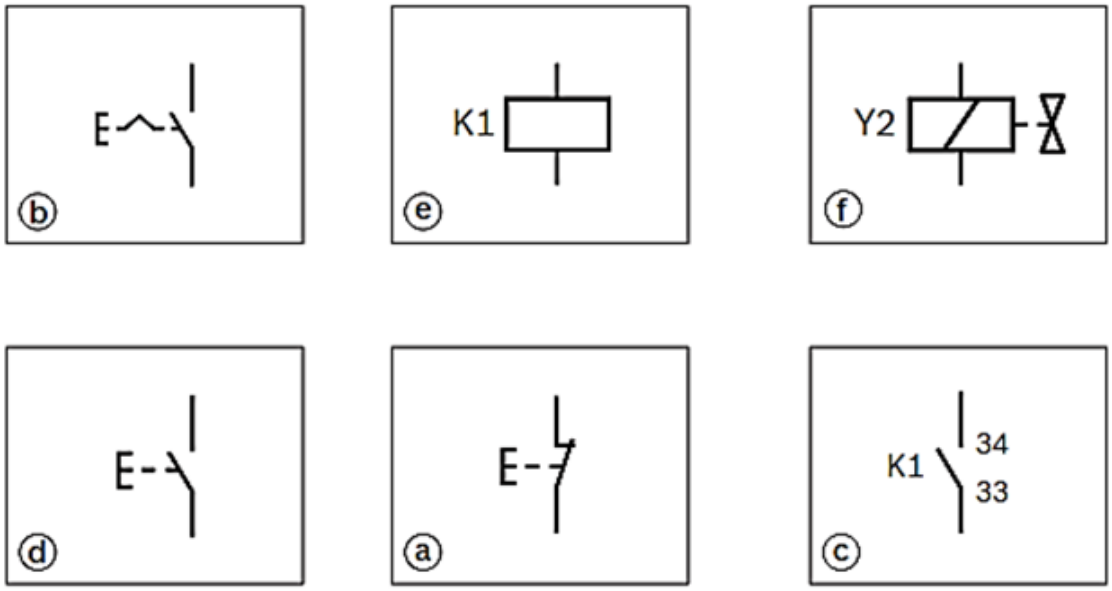



**Figure 1.3. Electrical Components**

| ELECTRICAL SWITCHING ELEMENT | SYMBOL IDENTIFICATION LETTER |
|---|---|
| Solenoid coil (for valve actuation) | |
| Relay | |
| Relay contact (NO) with contact numbers | |
| Switch (latching) | |
| Button (NC) | |
| Button (NO) | |

**Table 1.2(c)**

## Task 2: Actuation of the 4/3 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.

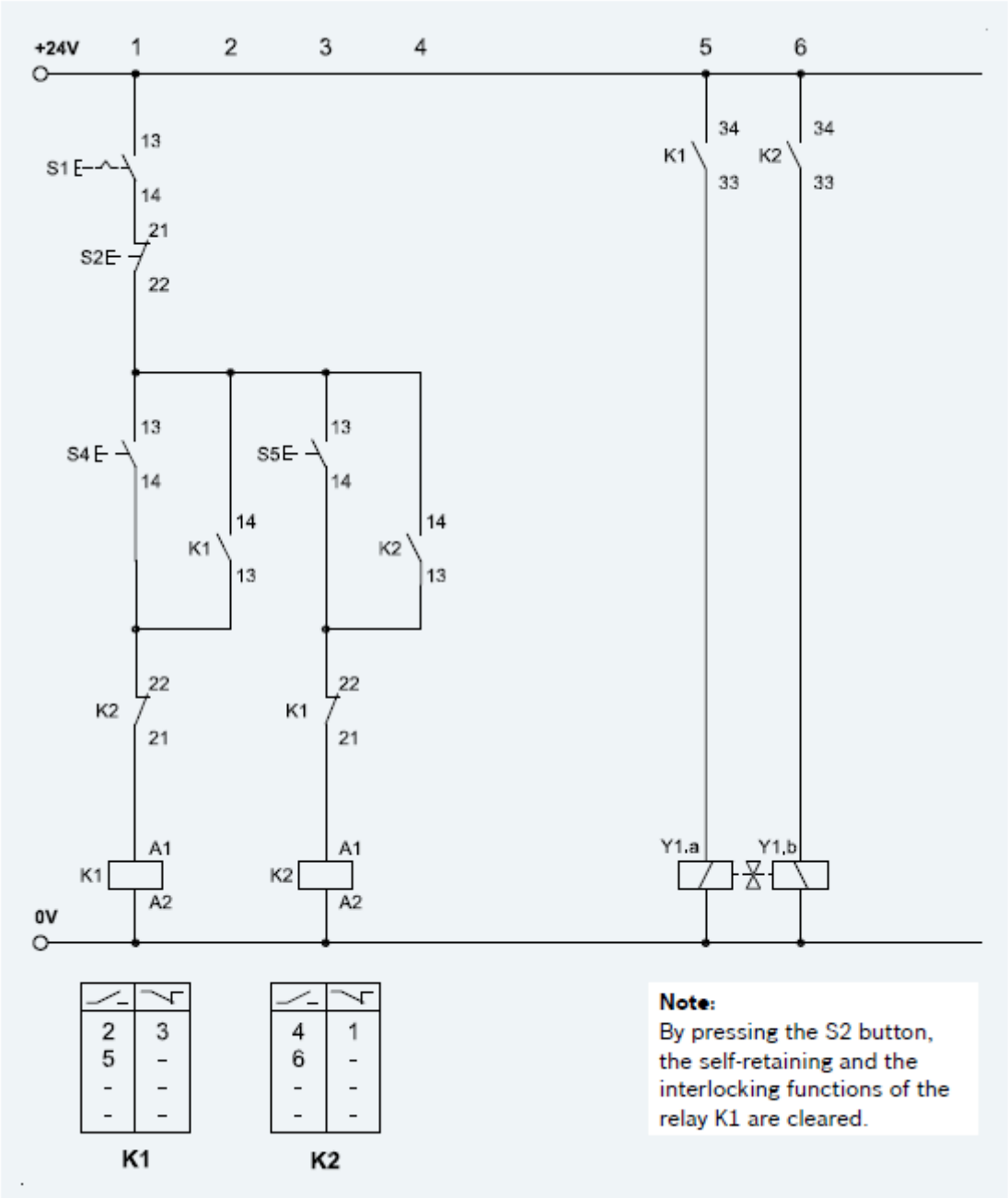
***Procedure***

1. Connect the hydraulic circuit according to Figure 2.1(a) using the components listed in Table 2.1(b).

| Item | Quan-tity | Designation | Type | Rexroth material number |
|---|---|---|---|---|
| 1.10 | 1 | Differential cylinder | CD70F25/16-200 | R961009526 |
| 1.20 | 1 | 4/3 directional control valve | 4WE6G6X/ | R961002548 |
| 1.30 | 1 | 4/3 directional control valve | 4WE6E6X/ | R961002549 |
| 1.40 [1)] | 1 [1)]/0 | Pressure relief valve | DBDH6G1X/100 | R961002520 |
| 1.50<br>1.51<br>1.52 | 3 | Manometer 0 to 100 bar | | R961002715 |
| 1.60<br>1.61<br>1.62 | 3 | Hose line 1,000 mm<br>with Minimess port | ZN10031-08-W90MM-1000 | R961004330 |
| 1.70 [1)]<br>1.71 | 2 [1)]/1 | Hose line 630 mm | ZN10031-08-W00NN-630 | R961002474 |
| 1.80 | 1 | for WS290: 2.5 l measuring glass | | R961002564 |
| | | for WS200: 1.6 l measuring glass | | R961009485 |

**Table 2.1 (b)**

2. Connect the electric circuit as shown in Figure 2.1(b).




3. Validate the hydraulic circuit and the electric circuit for any misconnection.

4. Functional testing of the electrical circuit:

- Move switch S1 of the control unit to switch position “1” (ON)
- Press the button S4 relay K1, is activated (LED from relay K1 lights up).
- Switching status remains actuated until button S2 (reset) is pressed
- By pressing the button S5 relay K2 is activated
- Switching status remains actuated until button S2 (reset) is pressed and self-retaining feature of relay K2 is removed:

5. Directional control valve with spool type G (pressure less circulation in the center position):

   - Connect the hoses according to the hydraulic circuit diagram 1 for , while taking care to observe the general and project-specific safety instructions. Connect the manometer for setting/monitoring the operating pressure to the measuring connection of the distributor on the workstation and screw it hand-tight. Connect the measuring hoses of the other manometers to the Minimess port of the respective hydraulic hose and tighten hand-tight.
   - Switch on the hydraulic power unit of the workstation and check the hydraulic setup for any leakage.
   - The initial position of the cylinder piston is the extended state.
   - All manometers must show zero pressure (except for the operating pressure display
   - Actuate the directional control valve (item 1.20) (press button S3), connection P - B
   - is established, the piston rod of the hydraulic cylinder retracts.
   - Record the measurements specified for the cylinder piston in the retracted end position.
   - Set an operating pressure at the pressure relief valve of 30 bar (manometer M1).
   - Bring the directional control valve into the central position (press reset button S2), connection P - T is established, the piston rod of the hydraulic cylinder does not move. Record the measurements specified for the directional control valve in the central position.
   - Actuate the directional control valve again (press button S4), connection P - B is established , the piston rod of the hydraulic cylinder extends.
   - Record the measurements specified for the cylinder piston in the extended end position.

6. Once you finish the practice, turn OFF of the Hydraulic Power Unit and DC Power Supply.

Task 2.1 (a): Based on your observation, fill in Table 2.1(a)

| **Position** | **Directional control valve switching position** | **M1** $p_1$ in bar | **M2** $p_2$ in bar | **M3** $p_3$ in bar | $q_V$ in l/min |
|---|---|---|---|---|---|
| Piston rod retracted | **P – B** | | | | |
| Piston rod extended | **P – A** | | | | |
| Valve spool in center position | **0** | | | | |

**Table 2.1 (a)**

# 3. PROBLEMS

## 3.1. Electro-Hydraulic - Application of Electro-hydraulic in Elevator

***Practice Objective***

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

***Assignment***

**Figure 3.1** illustrates the application of hydraulic in an elevator. Hydraulic elevator is supported by a piston at the bottom of the elevator that pushes/pulled the elevator up/down. The objective of this assignment is to design an electro-hydraulic circuit for the following requirements:

1. Piston is used to move the elevator to a certain level based on the pressed button.
2. The piston should move the elevator to a level accordingly to the button pressed (Eg. button S1 to level 1).
3. The elevator will stop at a certain level after being contacted with limit switch.

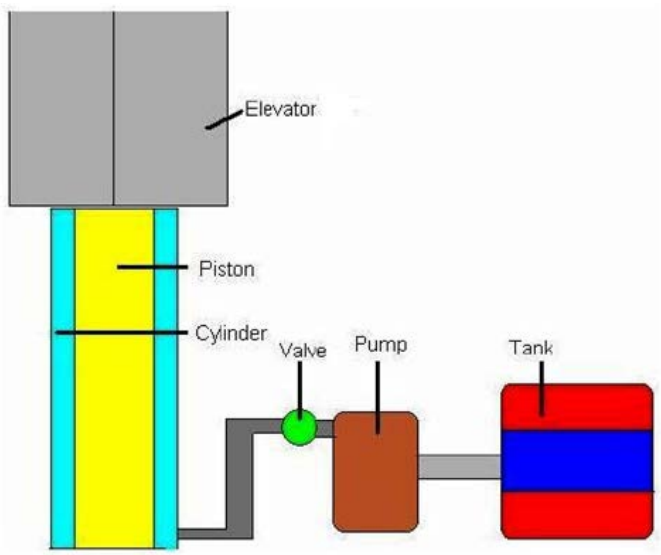



**Figure 3.1: Hydraulic Elevator.**

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

1. Use pushbuttons S1, S2 and S3 to respectively move the elevator to level 1, 2 and 3.
2. Use sensors to detect the positions of cylinders.
3. Use a 4/3 single-solenoid spring return control valve to actuate the cylinder.
4. Incorporates memory circuit for the all pushbuttons (S1, S2 and S3).
5. Use S4 to return to normal position. Include safety on pressure, return to the tank.

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.

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