UNL-FCT-DEEC, Automation and Control Technologies, 2022-23
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Labwork Lab#01 - Grafcet, Electropneumatic Technology and Electromagnetic Technology.

Rules: The PDF report should include all the information for evaluation, having a maximum of 12 pages. Quotation for each question: 20 %.

Q1. Invent an electropneumatic control scheme inspired on the setup "P3. EPM-TWD-2.3 " (Fig. 1, laboratory 2.3-X) to control an elevator, a door, a conveyor belt, or other dynamic process.
The fundamental components, 2 cylinders (double-action and single-action), valves, buttons and sensors, described in the course unit, must be incorporated in the scheme to be designed.
Consider that the electric push buttons B1 and B2, and the electric limit switches I7 and I8, are simulated with pneumatic technology, using 3/2 valves. Assume that the electric switch button B3 commands the unique solenoid valve VS1.
In the control scheme to be designed, you should also incorporate the pneumatic 3/2 valve with manual control (B0) that controls the air flow coming from the compressor.
Use the various valve command methods:

a) manual;
b) mechanical;
c) pneumatic;
d) electropneumatic (use only one valve solenoid VS1).

You can and should add also some additional components, such as:

i) 1 "AND" valve, 1 "OR" valve, 1 "NOT" valve, 1 bistable memory type valve, flow control valves and 1 on-delay "NC" pneumatic timer;
ii) 1 extra cylinder, more valves if needed, 2 pneumatic-electrical converters, 1 lamp and 1 buzzer.

a) Draw a picture with the sketch of the process, sensors and actuators;

b) Draw a picture with the control loop architecture (controller, actuators, process, sensors, etc) associated with the overall system;

c) For the automatism, describe the various types of specifications;

d) Draw the Grafcet (G7) of the automatism;

e) Simulate the closed-loop control system (automatism, process, sensors and actuators) in the Fluidsim 3.6 software, and check if it meets the specifications.

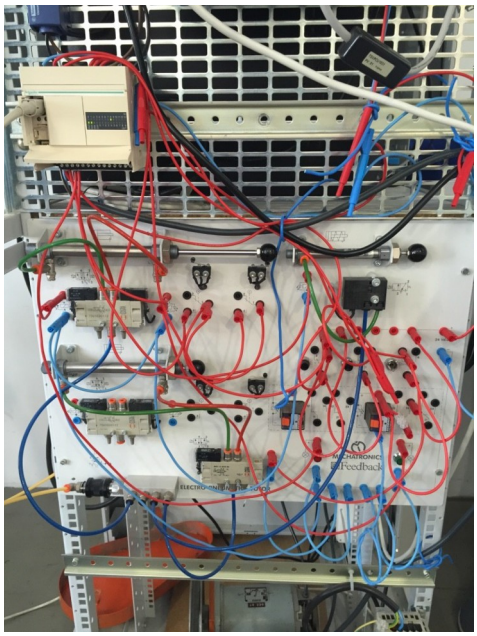

Fig. 1 – Electropneumatic process EPM-TWD-2.3.

Q2. In an industrial plant it is intended to control a conveyor belt, driven by a single-phase AC induction motor (MT) (Panasonic #), with electromagnetic technology (Fig. 2), in order to comply with the following functional specifications:

- after pressing the Start push button (B1, "NO"), the conveyor belt starts operating after 5 seconds;
- when pressing the Stop push button (B0, "NC"), the conveyor belt must stop immediately;
- the conveyor belt must stop if the limit switch sensor (S1) is activated.

The process "P12. AC1-REY-2.3 – Conveyor" present in the laboratory 2.3-X meets these specifications.

a) Draw the Grafcet for the automatism, taking into account also other relevant components present in the process, such as: general magnetic circuit breaker (DM, Telemecanique #), thermal relay (RT, Schneider #), lamp emulator with coil (EH, Telemecanique #) , etc.

Fig. 2 – Industrial conveyor belt.

b) Draw by hand the assembly diagram with the connections between all the components, incorporating the numbering of all component terminals;

c) From the assembly diagram, discover and draw by hand the electrical power circuit, where you must include the respective numbering;

d) From the assembly diagram, discover and draw by hand the electrical command circuit, where you must include the respective numbering ;

e) Simulate both the command and the power circuits in the Fluidsim 3.6 software, and check that they meet the functional specifications.

Q3. Consider the "freight elevator" scheme (Fig. 3), similar to the electromagnetic process "P7. ELE-REY-2.3" present in the laboratory 2.3-X.

Consider the following operation for the automatism, which is different from the laboratory-mounted system, although there are some similarities:
- the load moves between a lower platform (floor 0), where there is a limit switch (S0) that detects the presence of the bucket, and an upper floor (floor 1) where there is a limit switch (S1);
- the load is displaced by the action of a three-phase (3 ph) motor (MT), commanded by a KM1 contactor on the way up and a KM0 contactor on the way down;
- for the load to rise, it is necessary that the S0 sensor is activated for at least 5 s and that the push up button (B1) is pressed;
- when reaching the S1 sensor, the load remains 10 s on floor 1; after this delay, the load drops automatically;
- any movement can be stopped using the Emergency Stop (PE) push button;
- in the event of an emergency stop, the elevator must stop immediately; after stopping, the elevator only goes down to floor 0 if the push button B0 is pressed continuously, with the siren (H1) activated during the descent;
- the lamp (H2) should be on while the elevator is in motion.
- consider the following initial conditions: the elevator is stopped on the ground floor (0).

a) Draw the Grafcet for the automatism, taking into account also other relevant components present in the process, such as: general circuit breaker 300 mA (DD, Legrand #), thermal relay (RT, Telemecanique #), fuse (F1, ##), thermo-magnetic circuit breaker (F2, Schneider #), etc.

b) Design by hand the power scheme;

c) Design by hand the command scheme;

d) Simulate both control and power circuits in Fluidsim 3.6 software, and check that they meet the functional specifications.
Emulate the elevator using a double-acting pneumatic cylinder, controlled by electrovalves, using also flow control valves.

e) Draw the assembly diagram with the connections between all components, incorporating the numbering of all component terminals, in accordance with the electrical and power schemes, designed by hand.
The assembly diagram should allow the real assembly of both control and power circuits.

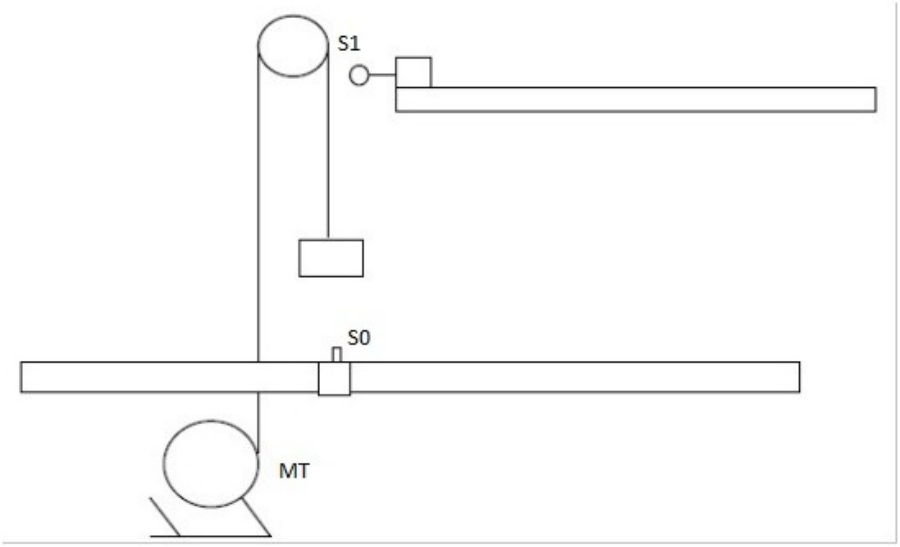

Fig. 3 – "Freight elevator" scheme driven by a three-phase motor (Efacec #).

Q4. Invent an automatism based on electromagnetic and electropneumatic technologies to control a double elevator (Fig. 4), that works between two floors.

a) Draw a schematics of the process with sensors and actuators, assuming electro-pneumatic elevators (with single-action and double-action cylinders);
b) Draw the Grafcet for the automatism;
c) Simulate the process and the automatism in the Fluidsim 3.6 simulator.

Fig. 4 – Double elevator "DE2".

Q5. Invent an automatism based on electromagnetic technology to control a traffic light (with 3 lamps RYG, Fig. 5), with a sensor that detects people.

a) Draw a schematics of the process;
b) Draw the Grafcet for the automatism;

c) Simulate the process and the automatism in the Fluidsim 3.6 simulator.

Fig. 5 – Traffic light (RYG).