Preliminary Design Review

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

Competence: Automation Technology

Workgroup: University of Cagliari

University of Cassino and Southern Latio

This document is the Preliminary Design Review of the technical competence 'Automation Technology'. Its briefly contains the experimental platform analysed in MISCE project, to be designed and standardised for improving the acquisition level of this competence on engineering degrees.

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Visit https://misceproject.eu/ for more information.

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1 Competence and skills

The conceptual design presented in this document is referred to the technical competence:

C1. Automation Technology

which related skills are (see Table I):

Table I. Skills of Automation Technology

S1.1.	To know the main electric/pneumatic and hydraulics elements
S1.2.	To be able to design the functional behavior of the system
S1.3.	To be able to understand the technical documentation of a project/product
S1.4.	To program the functional behavior of the device
S1.5.	To debug the final planned behaviour of the system

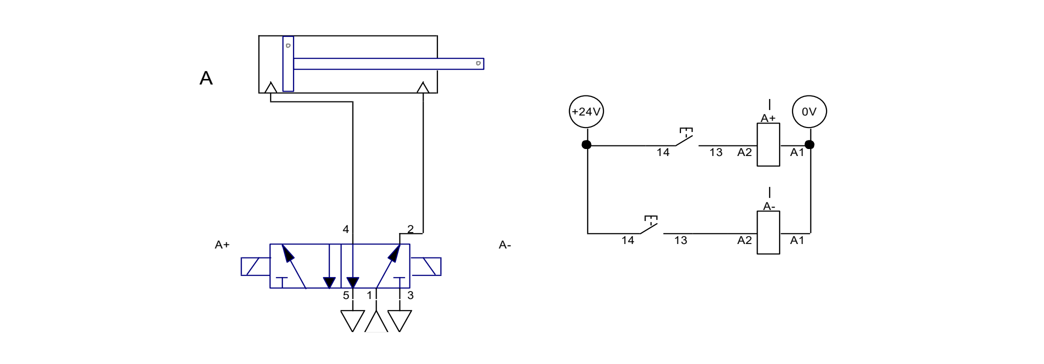
The different conceptual designs presented in this document have been analysed to ensure that can improve the acquisition level of the aforementioned competence.

2 Experimental proposals

For this application, the MISCE project proposes the use of a modular test bench consisting of three double-acting pneumatic cylinders, each equipped with two position sensors, and controlled via a Siemens PLC. This test bench shares some similarities with the previous system (TB 5), such as the use of double-acting cylinders and position sensors; however, it differs in the design and control system. Specifically, while TB5 features directional valves that control the cylinder movements, this new system (TB6) uses simpler valve configurations with two 3/2 monostable valves per cylinder, eliminating the need for additional flow regulators.

In both systems, the cylinders start from the negative end position, and the cycle is initiated by pressing a button (monostable type). However, the sequencing of the cylinders and the control logic differ slightly. In TB5, the cylinders are activated in sequence, and the system completes the cycle by simultaneously retracting all cylinders back to their initial positions. In contrast, TB6 introduces a delay after the activation of the cylinders, where a timer stops the circuit for about five seconds before allowing the cylinders to retract in reverse order.

Table II. Proposed devices for ‘automation technology’ competence



Actuation of a double effect pneumatic cylinder

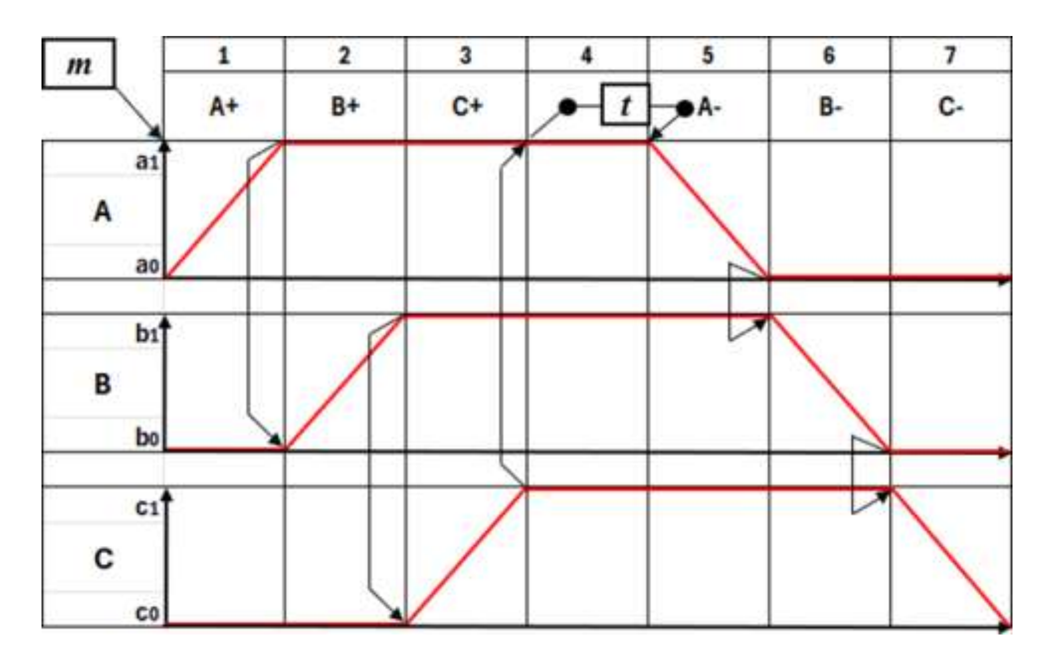


Diagram of Movement-Phase

The following sections provide a detailed explanation of each device involved in the system, as well as the corresponding teaching materials listed in Table II.

2.1 Actuation of a double effect pneumatic cylinder

The actuation of the double-acting pneumatic cylinder is a well-known concept in teaching activities related to automation technology (e.g., [4-6]). It consists of a double-acting pneumatic cylinder, a 5/2 (five-way, two-position) electro-pneumatic valve with electric actuation, and two electric push buttons. The movement of the pneumatic cylinder can be controlled either manually via the push buttons or automatically through a PLC. Additionally, the control objective of this platform is to regulate the velocity of the pneumatic cylinder (see Figure 1).

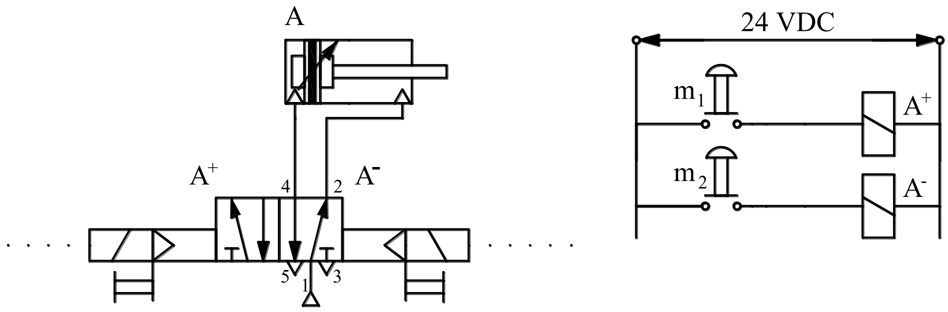


Figure 1. Double effect pneumatic cylinder

This device also incorporates the electronics and control equipment necessary to command the behavior of the cylinder via an electronic board (e.g., Arduino, Raspberry Pi, PLC, etc.). This exercise complements the pneumatic/electropneumatic test bed by adding more functionality to the basic control approach, allowing for more complex control strategies such as velocity regulation and automated sequencing.

2.2 Diagram of Movement-Phase

To create a suitable "Movement-Phase" displacement, using the previously described experimental platform, it will be possible to generate all types of required/desired movement/phase diagrams. The control objective is to create all possible combinations of cylinder movements through the experimental/numerical (Digital Twin) platform (see Figure 2).

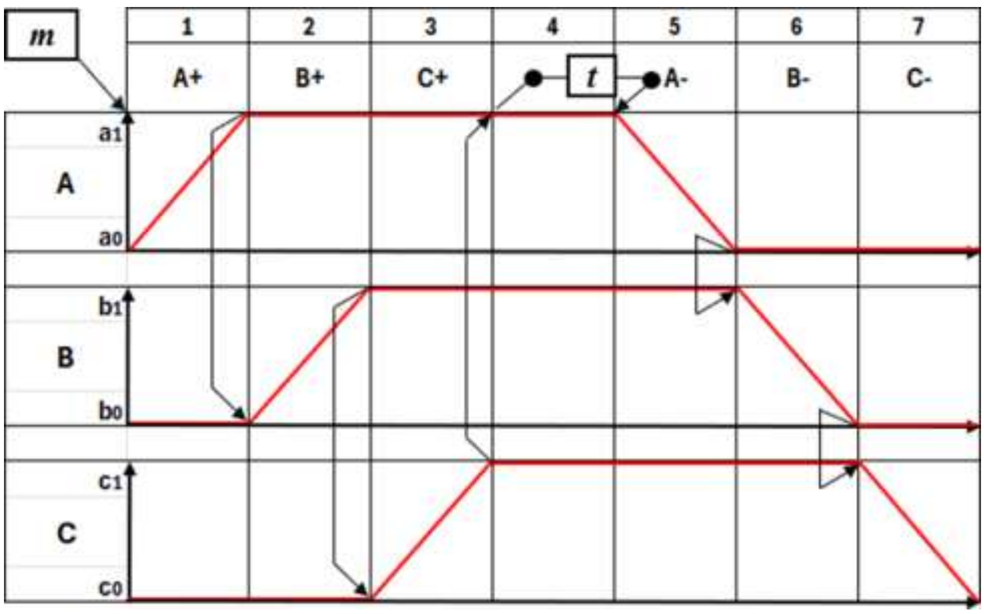


Figure 2. Generation of a suitable “Movement-Phase” displacement

This experimental platform is enhanced with more complex capabilities, adding advanced features for controlling and simulating the movements.

3 Competence and skills analyses

Table III summarises the competence and skills analyses of the proposed experimental platform attending to the contribution of acquisition of the technical competence ‘automation technology’ and their corresponding skills in Table I.

Table III. Contribution of each proposed platform to automation technology competence and its corresponding skills

Platform	S1.1	S1.2	S1.3	S1.4	S1.5	Overall competence contribution
Actuation of a single acting pneumatic cylinder	★★★★☆ Know the main electric/pneumatic and hydraulics elements	★★★☆☆ To be able to design the functional behaviour of the system.	★★☆☆☆ Ability to understand the technical documentation of a project/product.	★★☆☆☆ Ability to program the functional behaviour of the device	★★★☆☆ Capability to debug the final planned behaviour of the system	★★★★½ 4.2
Actuation of a double acting pneumatic cylinder	★★★★☆ Know the main electric/pneumatic and hydraulics elements.	★★★☆☆ To be able to design the functional behaviour of the system.	★★★★☆ Ability to understand the technical documentation of a project/product.	★★★★☆ Ability to program the functional behaviour of the device	★★★★☆ Capability to debug the final planned behaviour of the system.	★★★½☆ 3.6
Movement-Phase" displacement	★★★★☆ Know the main electric/pneumatic and hydraulics elements	★★★☆☆ To be able to design the functional behaviour of the system	★★★★☆ Ability to understand the technical documentation of a project/product.	★★★★★ Ability to program the functional behaviour of the device	★★★★★ Capability to debug the final planned behaviour of the system	★★★★☆ 4.0

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