Introduction to Mechatronics (MCT 151)

Sheet 1: Design Methodology for Mechatronic Systems

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Question one

Define the objectives of the VDI 2206 guidelines.

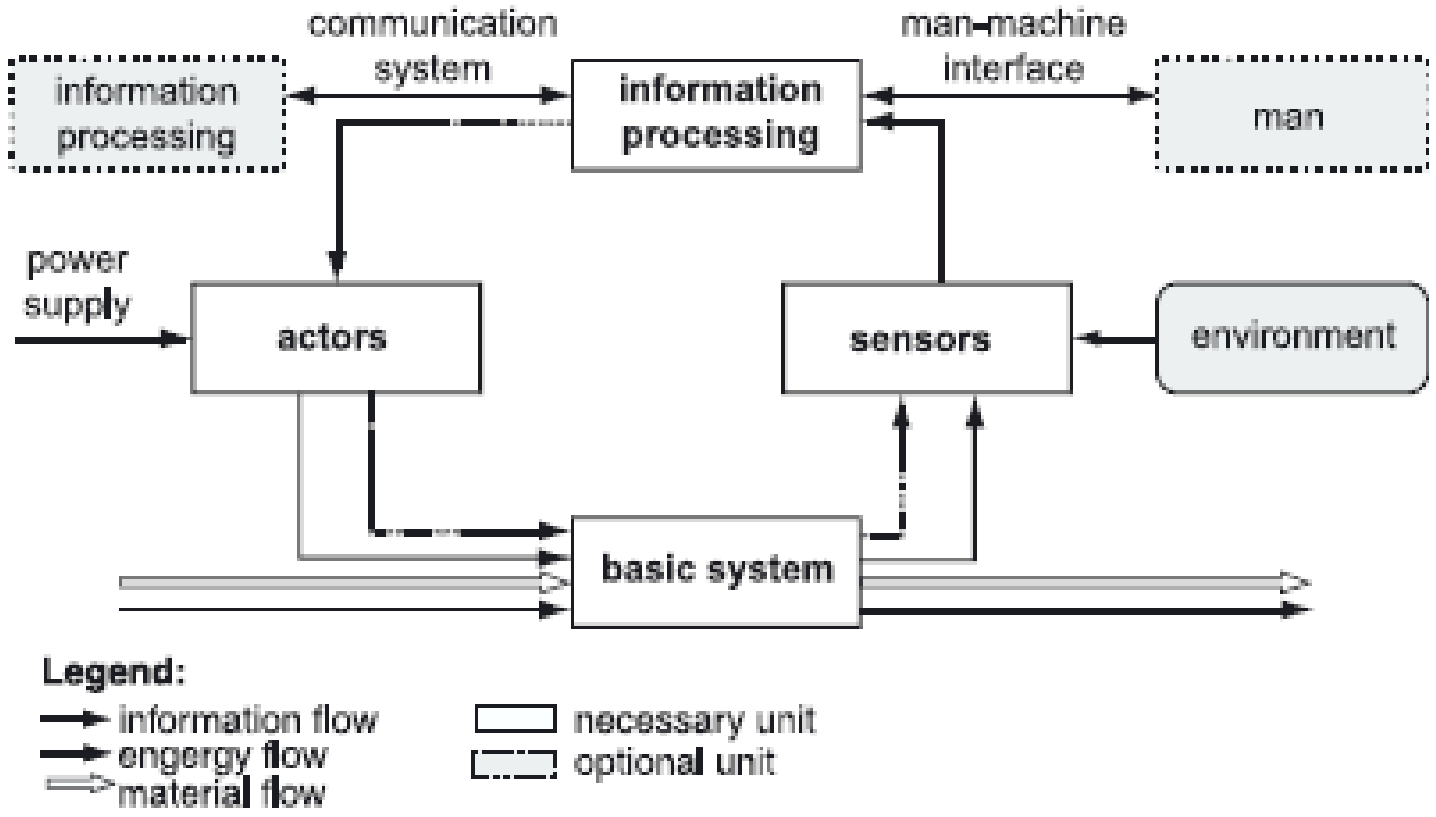
- The objective of VDI 2206 guidelines is to *provide* methodical support for the cross-domain development of mechatronic systems. The main aspects are in tended to be the procedures, methods and tools for the early phase of development, concentrating on system design. The result of system design is the assured concept of a mechatronics system. (This is understood as meaning the solution established in principle and checked by verification and validation). Depending on the application and risk assessment, different validation accuracies are required: the validation of the concept may be performed on the virtual prototype, on the partly real prototype or on the completely real prototype.

- The present guideline relates preferably to the mechatronic systems that comprise discrete mechanical and electronic components in symbiosis with the information technology.

- The guideline is intended to contribute to presenting the diversity of knowledge acquired in recent years by research and practical work and make it available to practitioners in the form of a guideline for the development of mechatronic systems. Application examples are to be used as a basis for illustrating the implementation of the guideline and at the same time the potential for the success of mechatronic solutions.

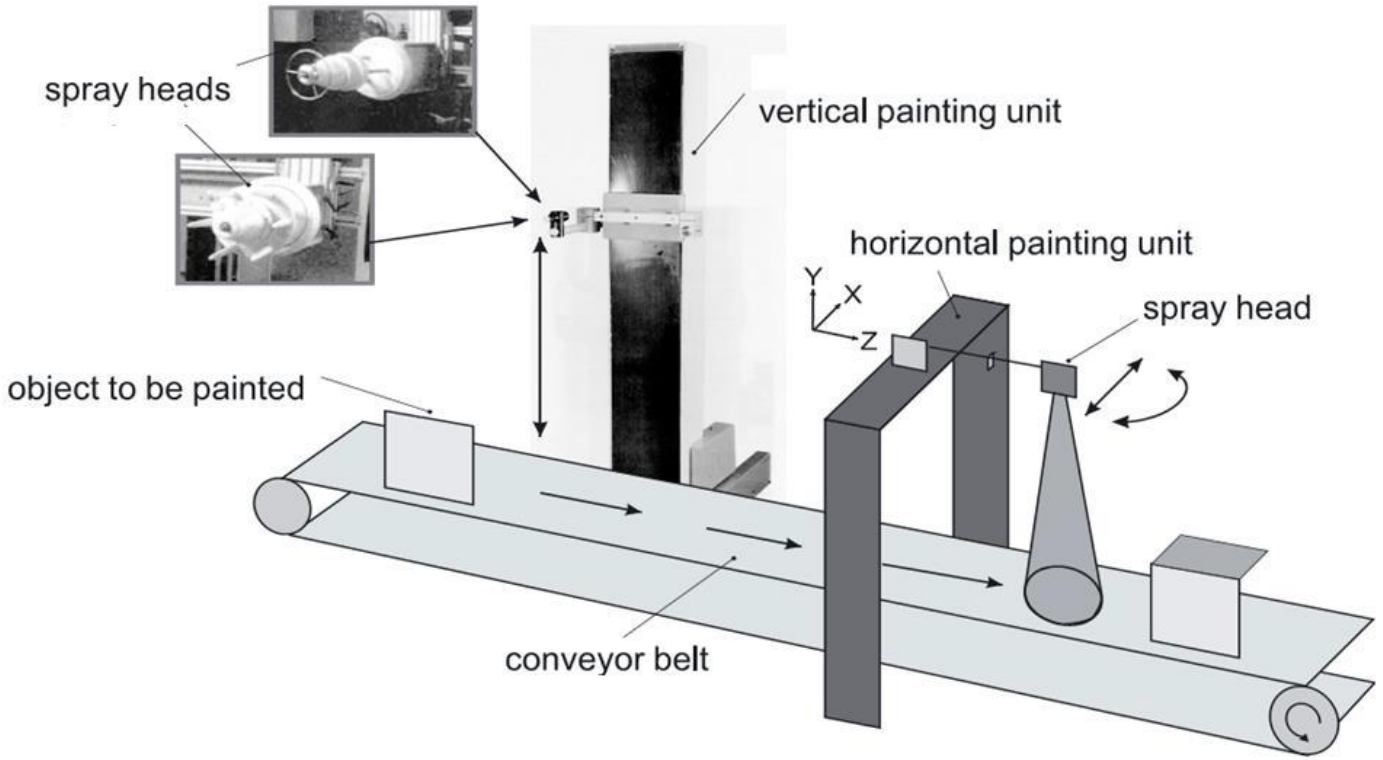
Question two

Sketch the basic structure of mechatronics system according to the VDI 2206



Question three

For painting mass-produced articles (kitchen appliances, audio and video equipment, aluminum wheel rims), painting systems in the form of continuous lines are often used. On these, the objects to be painted pass continuously through the system on a conveyor belt. The paint is applied by a number of spraying units, the oscillating movement of which runs either vertically (for the side surfaces of the object) or horizontally (for the upper side of the object) as shown in the following Figure . According to VDI 2206, design a mechatronic system for this process.

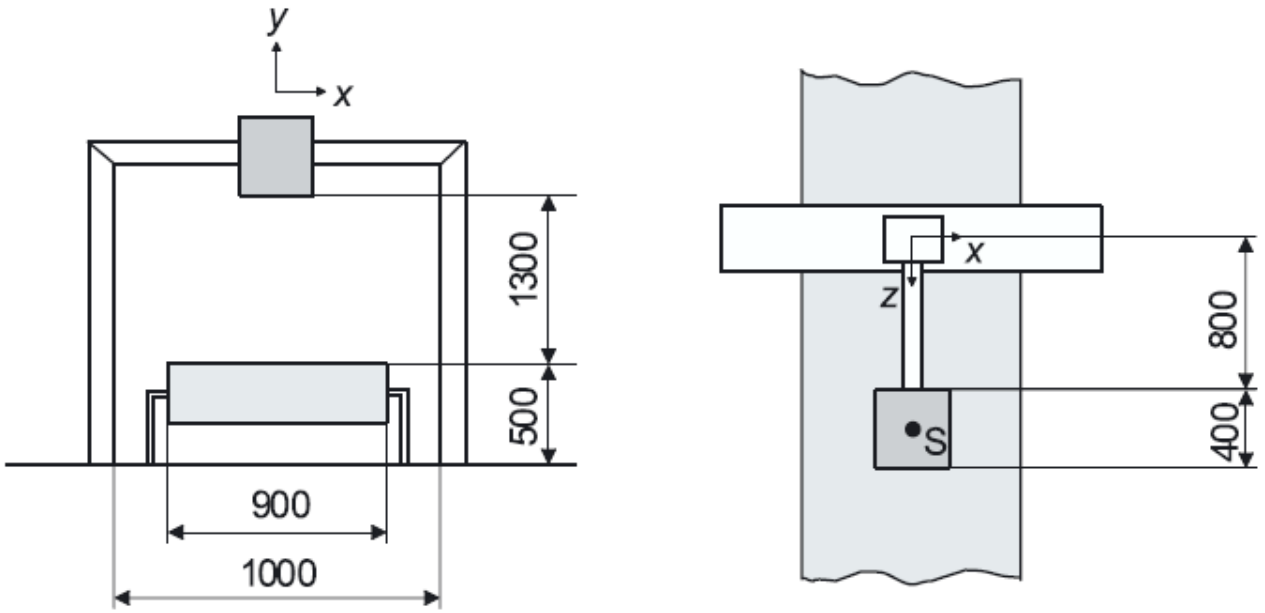


Question Three

Answer

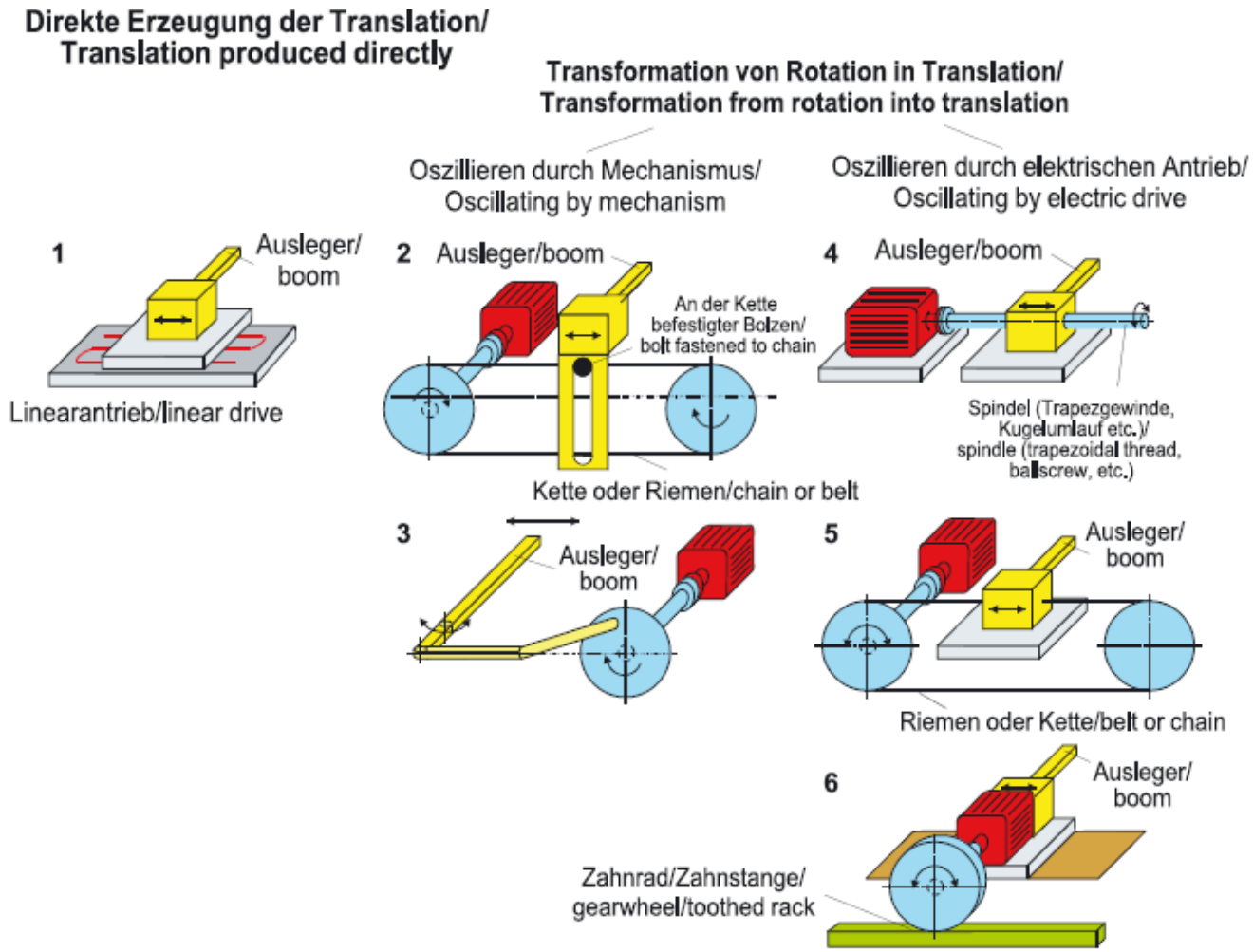
Selected Requirements:

- Desired speed in x direction 1 m/s.
- Distance at constant desired speed in x direction over the belt: 700 mm (ideally: 900 mm)
- Maximum oscillating: amplitudes : in x direction in the range of constant desired speed ±3 mm (ideally: ±2 mm) electric drive



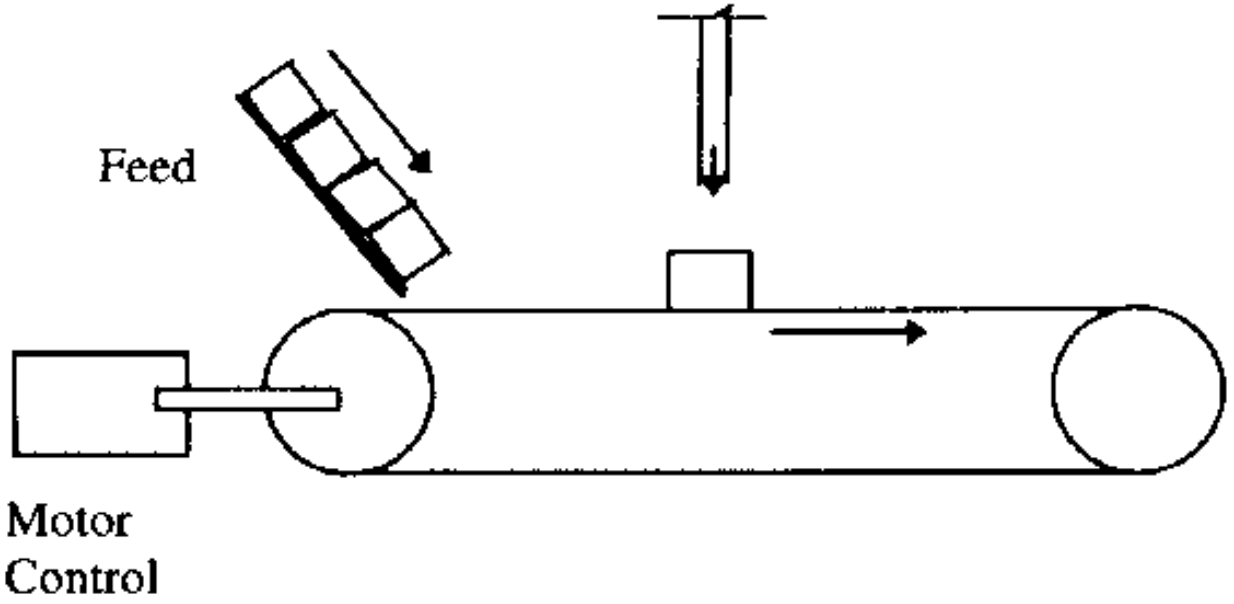
Question three

variants of type 2 represent a solution that is customary in practice, but have great problems with mechanical loads and wear in the connecting link guide and also lead to inflexible kinematics in the returning area. Therefore, variant 5 with a brushless DC motor in combination with a toothed
belt drive is to be considered by way of example.



Question four

A bottling plant uses an automated mechanism for filling the containers and transporting them from one point to another as shown in Figure 2. The sensors monitor the amount of solid or liquid filled. A conveyor mechanism transports the containers. Under the concept of VDI 2206, design a mechatronic system for the case described. Identify the types and features of sensors you use, describe how the system works and explain how you are going to interface and control the system. Make suitable sketches if needed.



Question four

Answer

Selected Requirements:

- Desired conveyer speed direction 1 m/s.
- Distance at constant desired speed in x direction over the belt: 700 mm (ideally: 900 mm)
- Considering oscillation of the belt to maintain bottles stability
- 500 mm3 is the volume of the bottle should be filled in 10seconds

Identifying needed sensors

Detecting new bottle on the conveyor is the most important process in that system and there are several possible techniques and technologies to detect it these possible solutions examples

- Infrared sensors (IR sensors)
- Computer vision (Cameras)
- Laser sensors

For simplicity the selected sensor will be IR sensors.

Question four

IR Features

- Selected kit infrared transmitter (emitter) and receiver (detector) from operate at 940nm
- The emitter is driven up to 50mA with a current limiting resistor as with any LED device
- Its Maximum range to detect an object is 150 cm

Pump Selection

The pump will supply the flow rate (gph) of the fluid should be selected based on the requirements

- Filling time which depends on the type of fluid , speed of the fluid required
- Area of the tank and pipe
- Bottle volume

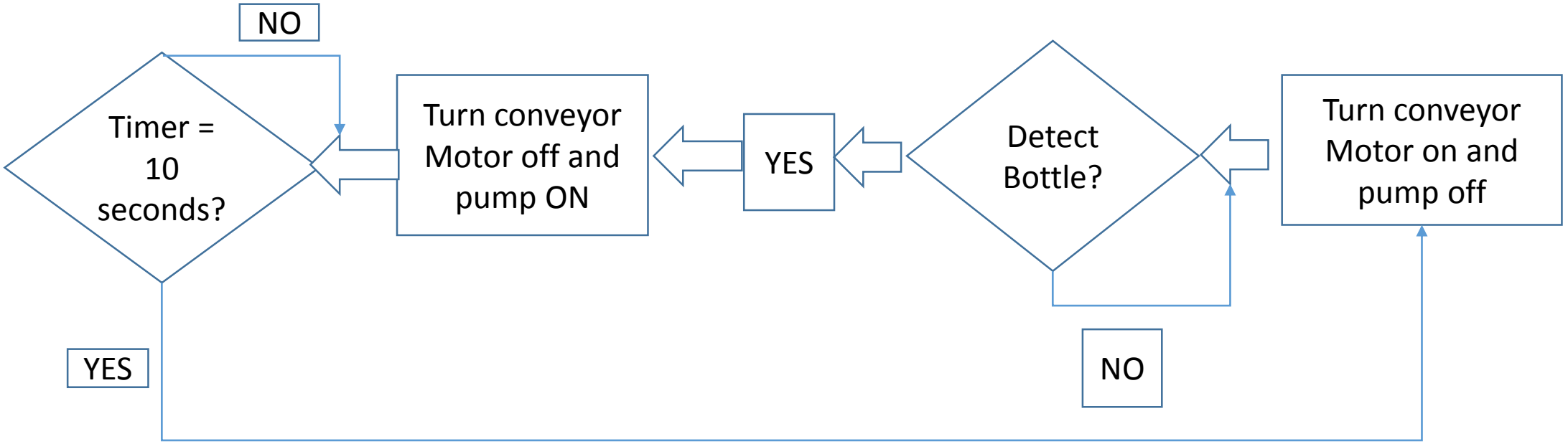
From the requirements we noted the required time to fill the bottle is **10 seconds** that means the fluid flow rate at the end of pipe should be **50 mm^3/second** which is equivalent to 3.95 gallon/ hour ($gal\ h^{-1}$)

Note that: 1 cubic millimeter per second = 0.00079 gallons per hour

Question four

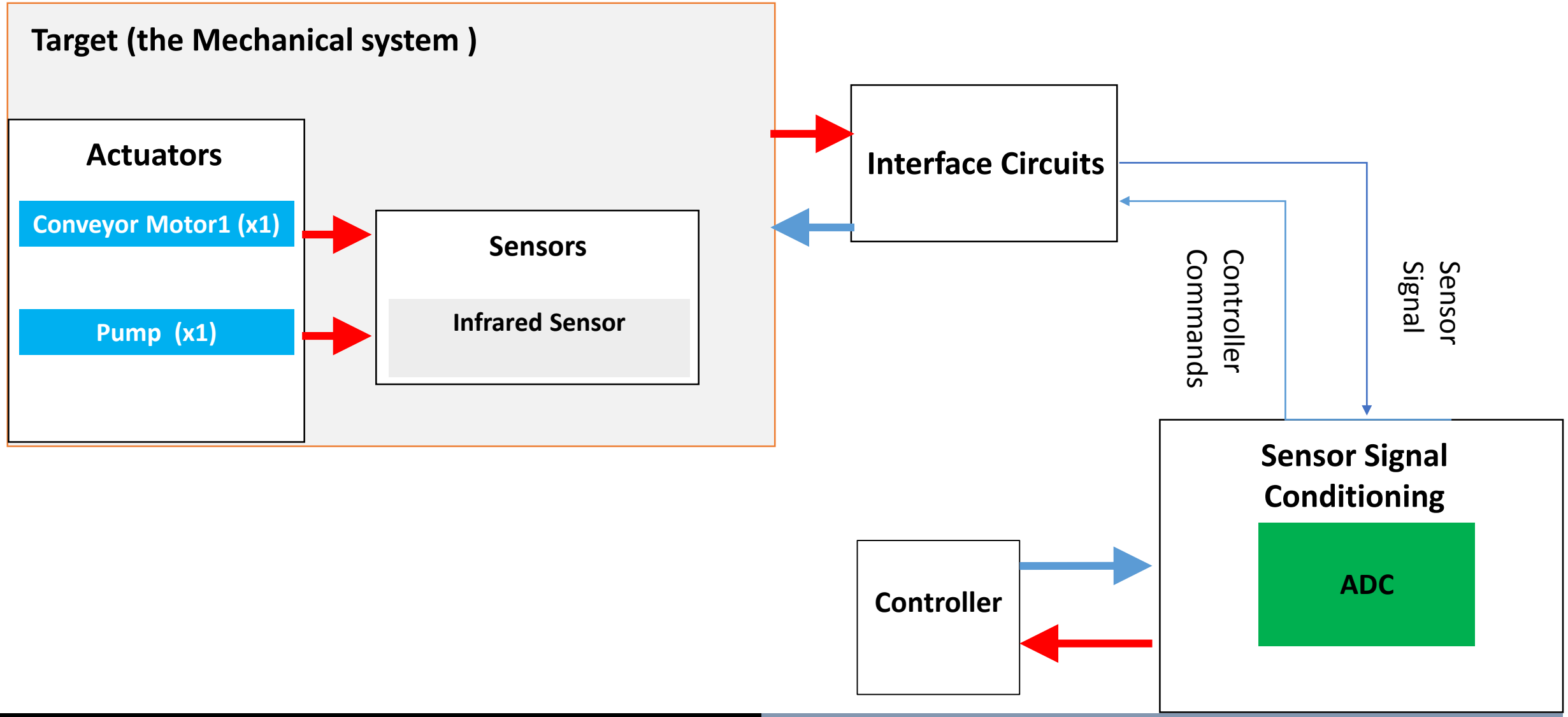
How the System works ?

Assuming ideally system works without delays so the IR sensor will be placed below the fluid valve , therefore when the motor that derives the conveyer starts bottle will be fed to the direction of the valve for filling mission, once detection is occurred , the conveyor must be stopped for 10 seconds so that the bottle could be filled, counting 10 minutes will be the mission of either external timer or internal on placed in the controller. After the bottle is completely filled , the motor should continuously derive the conveyor.



Question four

Controller Interfacing



Required Report

In the previous question You are required to increase the flexibility of the system by designing a user interface Panel so that the user can change the filling volume anytime. Redesign the mechatronics system to match this additional requirement. Also mention the formula that will convert the input volume into seconds required for the timer.