

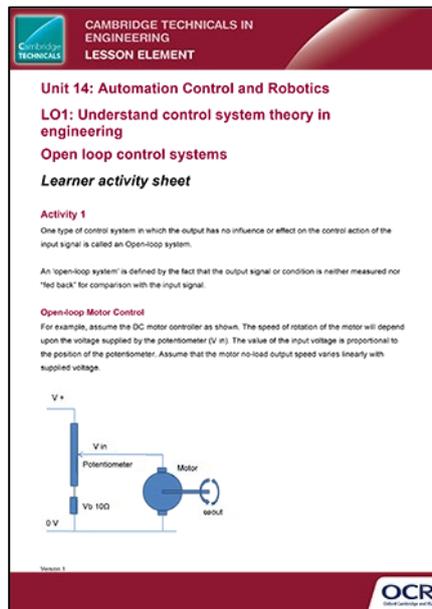
Unit 14: Automation Control and Robotics

LO1: Understand control system theory in engineering

Open loop control systems

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Open loop control systems' activity which supports Cambridge Technicals in Engineering Level 3.



Unit 14: Automation Control and Robotics
LO1: Understand control system theory in engineering
Open loop control systems
Learner activity sheet

Activity 1
 One type of control system in which the output has no influence or effect on the control action of the input signal is called an Open-loop system.

An 'open-loop system' is defined by the fact that the output signal or condition is neither measured nor 'fed back' for comparison with the input signal.

Open-loop Motor Control
 For example, assume the DC motor controller as shown. The speed of rotation of the motor will depend upon the voltage supplied by the potentiometer (V_{in}). The value of the input voltage is proportional to the position of the potentiometer. Assume that the motor no-load output speed varies linearly with supplied voltage.

Diagram: A circuit diagram showing a DC power supply with terminals labeled $V+$ and $0V$. A potentiometer is connected between $V+$ and $0V$. The wiper of the potentiometer is labeled V_{in} and is connected to a DC motor. The motor's output is labeled 'output'.

Version 1 

The Activity:



This activity offers an opportunity for English skills development.



This activity offers an opportunity for maths skills development.

Suggested timings:

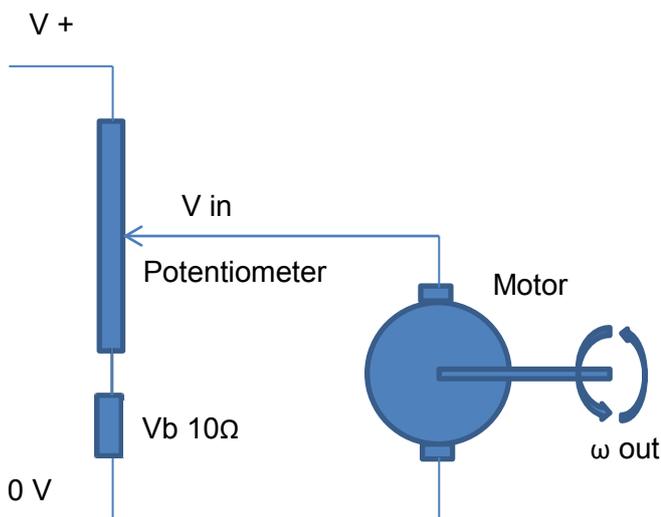
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Open-loop Motor Control

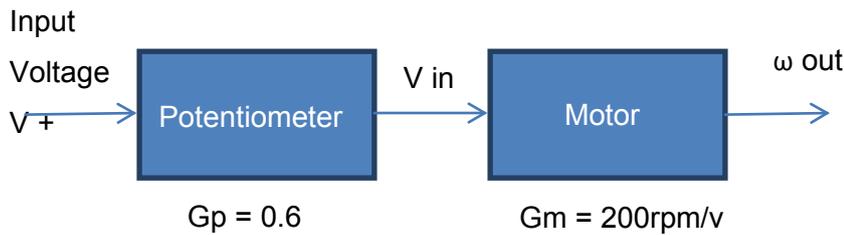
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If the potentiometer is moved to the top of the resistance the maximum positive voltage will be supplied to the amplifier representing full speed. Likewise, if the potentiometer wiper is moved to the bottom of the resistance, zero voltage will be supplied representing stop.

The position of the potentiometers slider represents the input, θ_i to drive the DC motor (process) at a set speed N (ω_{out}) representing the output, θ_o of the system. The motor will continue to rotate at a fixed speed determined by the position of the potentiometer.

If the gain of the motor is 200rpm/volt, $V+$ is 12 volts and the gain of the potentiometer is adjusted to 0.6, construct functional block diagrams of the system and calculate the no-load speed of the motor.



$$G_m = \frac{\omega_{out}}{V_{in}} \rightarrow G_p = \frac{V_{in}}{V+}$$

$$V_{in} = 12 \times 0.6 = 7.2 \text{ v}$$

$$\omega_{out} = 200 \times 7.2 = 1440 \text{ rpm}$$

Activity 2

If you have access to a DC motor, power supply and potentiometer, connect up a circuit as above.

Set the potentiometer to its zero voltage position and switch the power supply on. Move the position of the potentiometer and observe the effect on motor speed. If there is a tachometer, record the input voltage V_{in} and the output speed (ω_{out}) for different positions of the potentiometer with the motor at no-load.

Plot the data recorded on a graph. Is the shape linear? Can you determine a gain for the motor under no-load conditions?

Apply a load to the motor output. Observe what happens to the motor speed. Observe how the potentiometer (correction element) of an open loop system does not adjust to maintain the motor speed at its no-load condition.

Write down 2 applications where an open loop control system might be suitable.

Equipment can be sourced from an electronics supplier such as RS components or Maplin.

A low power brush DC motor.

A potentiometer 1 W, 1k Ω .

A resistor 1W, 10 Ω .

A power source battery or low voltage power supply.

Wires to connect.

A board to mount the items on.

It is suggested that the apparatus is pre-assembled with perhaps the learners connecting wires via push terminals. The apparatus can be modified to demonstrate activity in closed loop control systems and pulse width modulation elements of the unit.

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