

Engineering Science

Introduction to Systems



System Diagrams



Control Systems

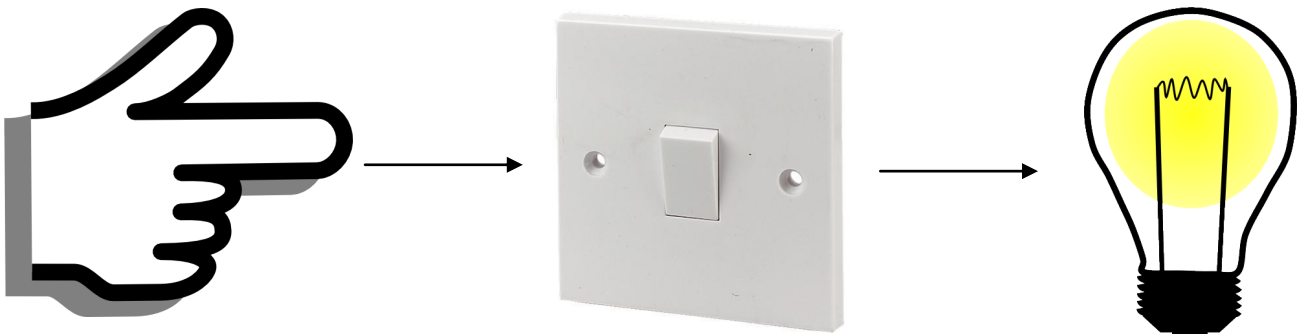
All systems require some form of control to make them work properly. This can be done by people (Manual Control) or by technological devices (Automatic Control).

There are two main ways of controlling systems—Open Loop Control and Closed Loop Control.

Open Loop Control

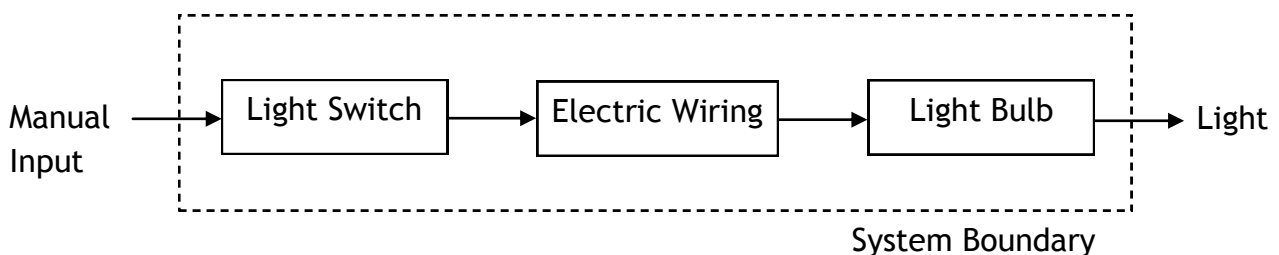
Open loop control is the simplest type of control and it is the most common type. It is widely used in the home and industrial systems because it is simple to operate and cheap to install.

For example, domestic lighting systems usually have open loop control. The input is the action of pressing a light switch and the output is the light from the filament of the bulb.



As the action and the decision to put on the light would be done by a human being, this is fully described as Manual, Open Loop Control.

A sub-systems diagram of a room lighting system is shown below.



Assignment 1 - Open Loop Control

Redraw the systems diagrams shown below, filling in the missing inputs, processes and outputs into your jotter.

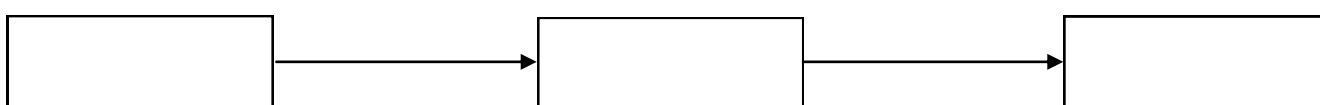
Torch



Cash Machine



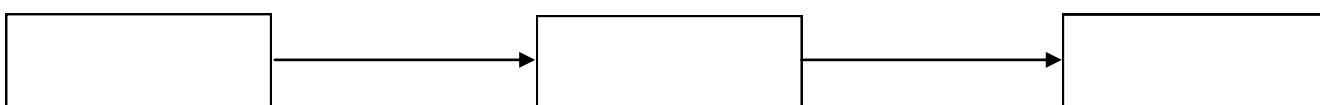
Gas Fire



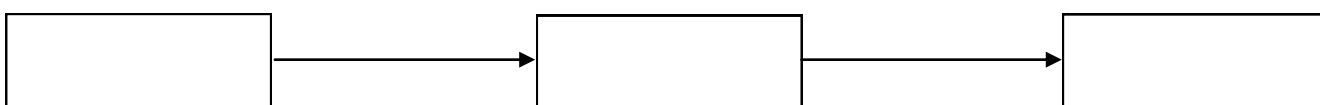
DVD Player



Microwave

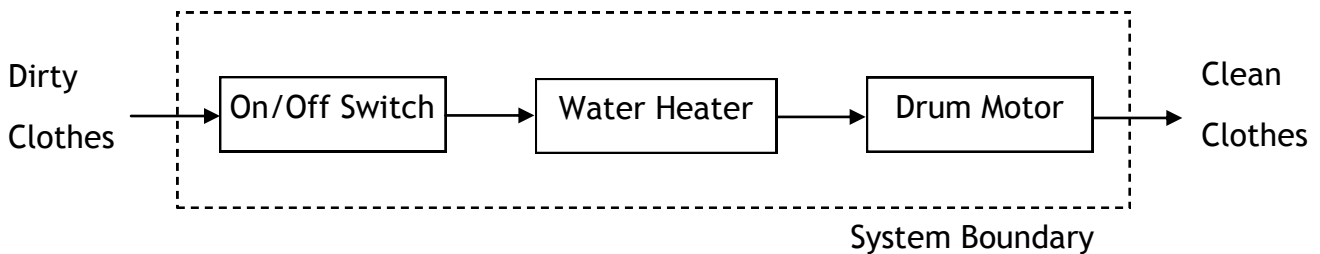


Vending Machine



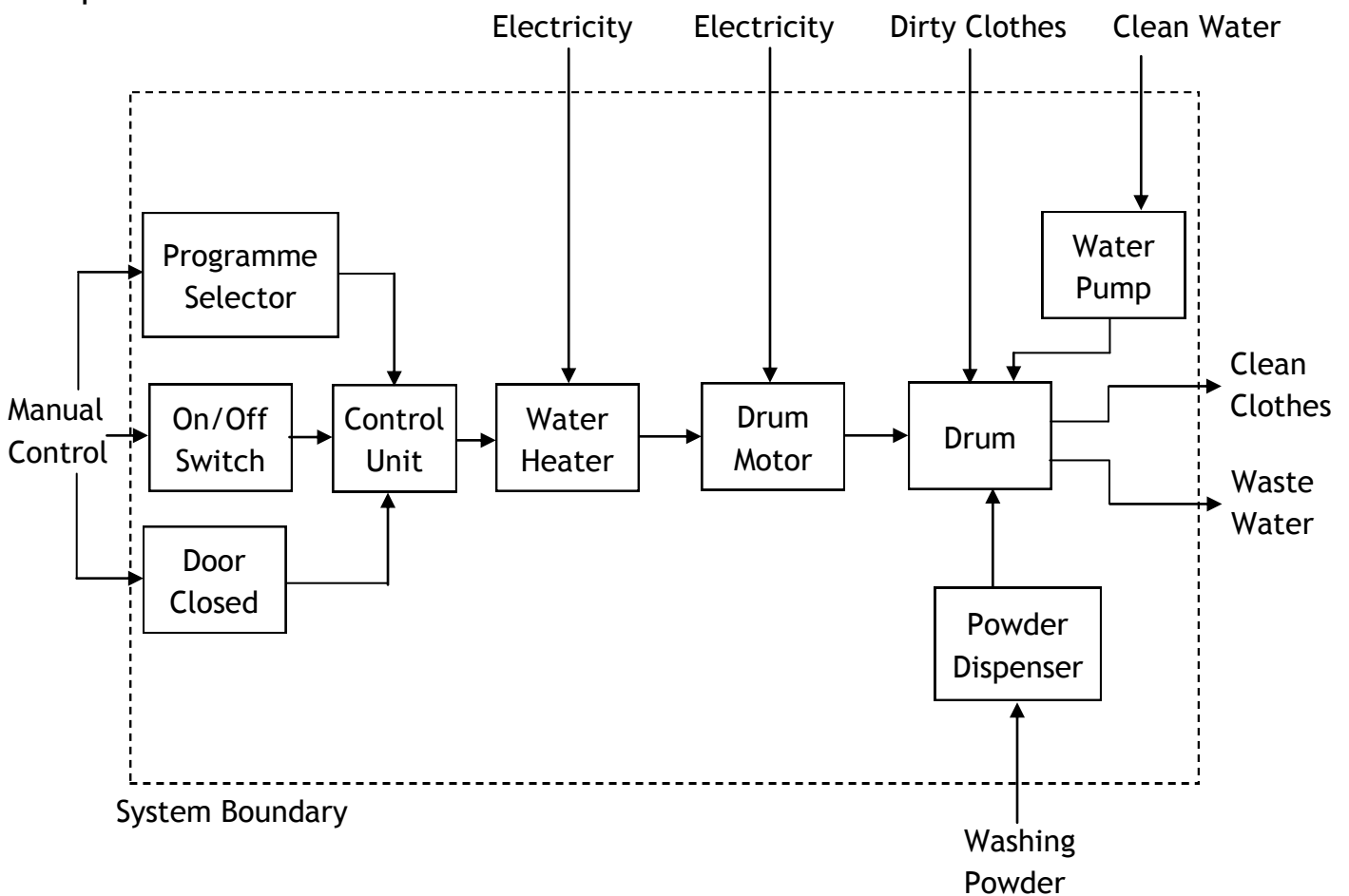
Sub-Systems

The Universal System can be broken down into a number of sub-systems. For example, a sub-systems diagram of a washing machine could look like this.



A systems boundary is drawn with a broken line. It represents the limits of the system. Note that the inputs and outputs are the only things that cross the system boundary.

A full sub-systems diagram of the washing machine could be a bit more complicated.



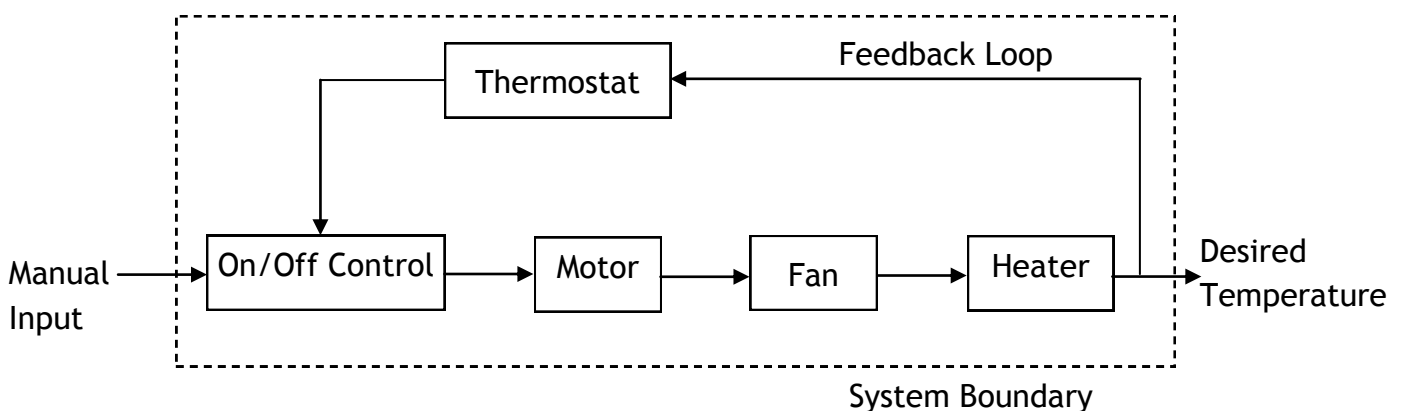
Closed Loop Control

Closed Loop Control is more complicated and more expensive than Open Loop Control but it is more accurate at controlling domestic and industrial systems.

Closed Loop Control systems are capable of making decisions and adjusting their performance to suit changing output conditions. A good example is a thermostatically controlled fan heater.



A sub-systems diagram for the fan heater is shown below. A sensor is used to measure the temperature of the room. Once the desired output is achieved, this type of heater will automatically switch off. Equally, if the room temperature falls too low, the heater will come on automatically.



Feedback Loops

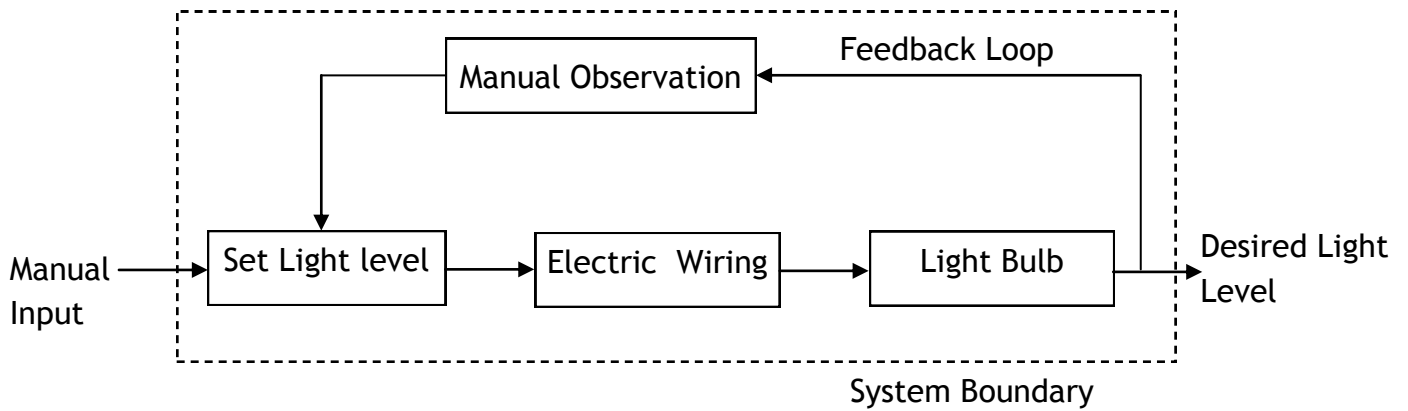
Automatic Closed Loop Control

The heater is a good example of this. The sensor measures the temperature output and sends a signal back to the input—this is called a feedback loop. This is fully described as Automatic, Closed Loop Control.

Manual Closed Loop Control

There may or may not be a physical link between the output and the input. Both the monitoring and the control unit operation may be done manually.

For example, the light level in a room could be controlled with a dimmer switch. The light level in the room can be measured by a human eye and the switch adjusted manually to give exactly the light level required. This is fully described as Manual, Closed Loop Control.

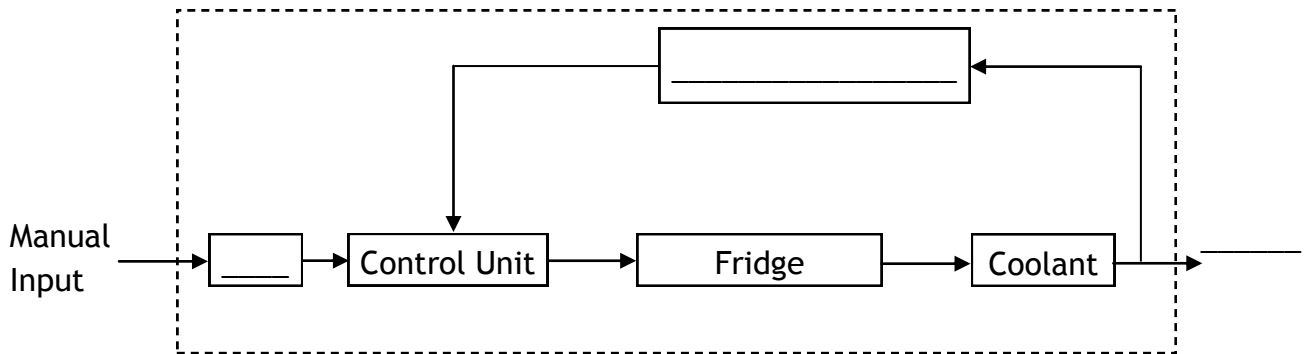


A Closed Loop Control system can always be identified by the presence of a feedback loop. The feedback and control can either be Manual or Automatic. An Open Loop Control system never has a feedback loop.

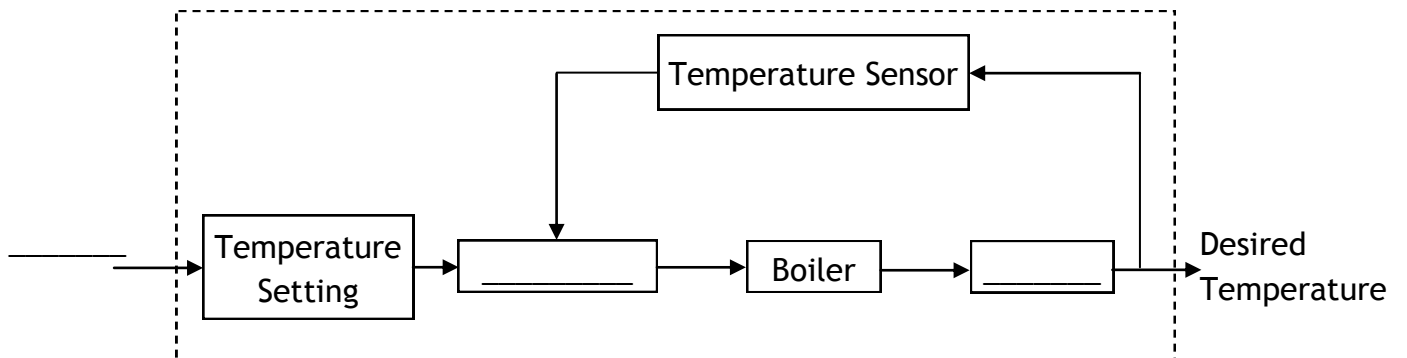
Assignment 2 - Closed Loop Control

Redraw the systems diagrams shown below, filling in the missing sub-systems into your jotter.

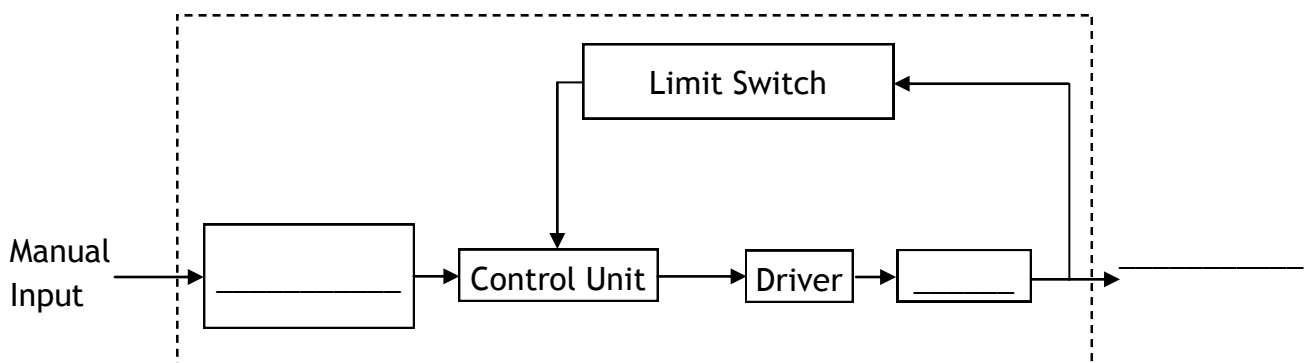
Fridge



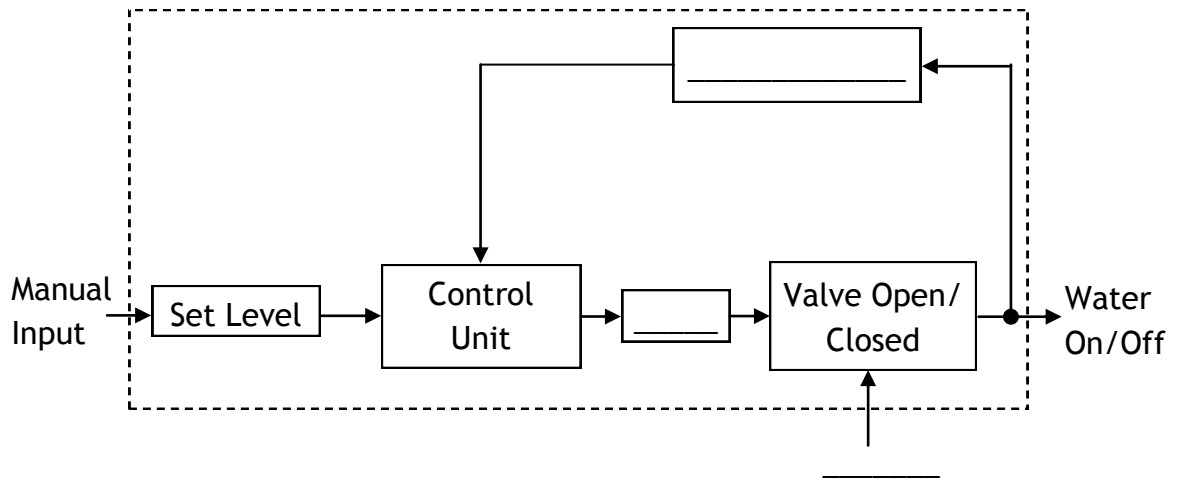
Central Heating



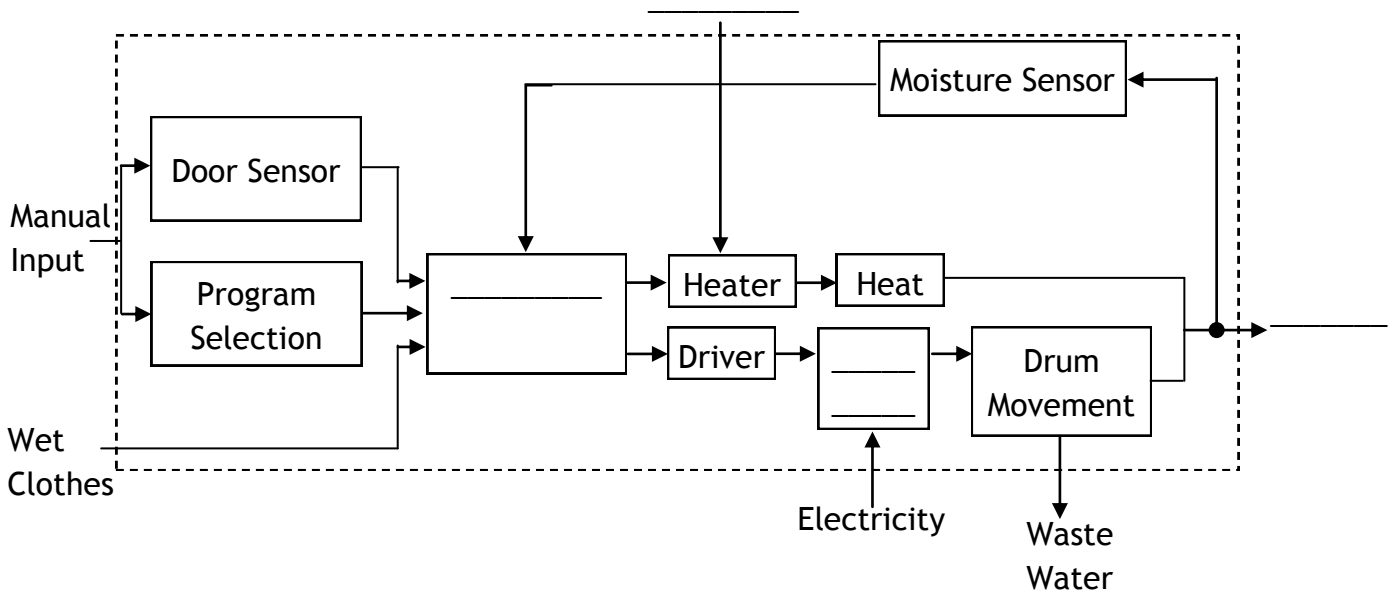
Stadium Roof



Sprinkler System



Tumble Dryer

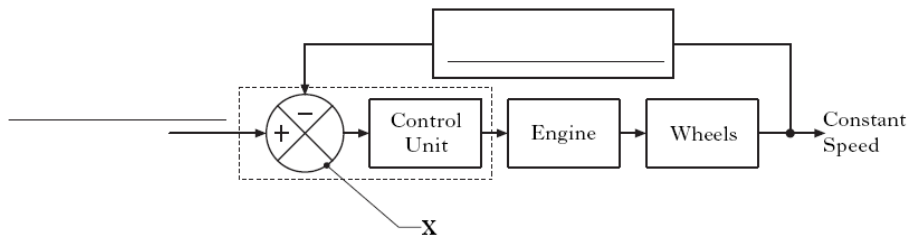


Homework

1. A) Draw the Universal Systems Diagram.
B) Draw a systems diagram for the cement mixer shown. Show all inputs and outputs.



2. A manufacturer wants to use a cruise control system to keep a car's speed constant even when it goes up and down hills. The system should allow a driver to take their foot off the accelerator once the desired speed has been set.
A) Complete the systems diagram below for the cruise control system.



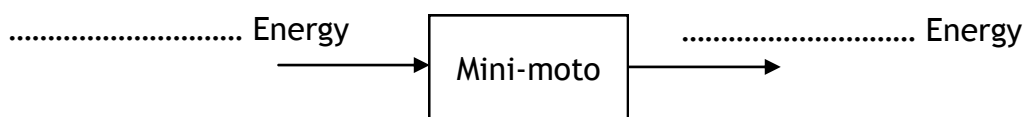
- B) This control systems makes use of a feedback loop. State the type of control produced by this automatic system.
3. Give 3 further examples of Open Loop Control. Draw a systems diagram for each, showing all inputs and outputs.
4. Give 3 further examples of Closed Loop Control. Draw a systems diagram for each, showing all inputs and outputs.

Problems—From past papers

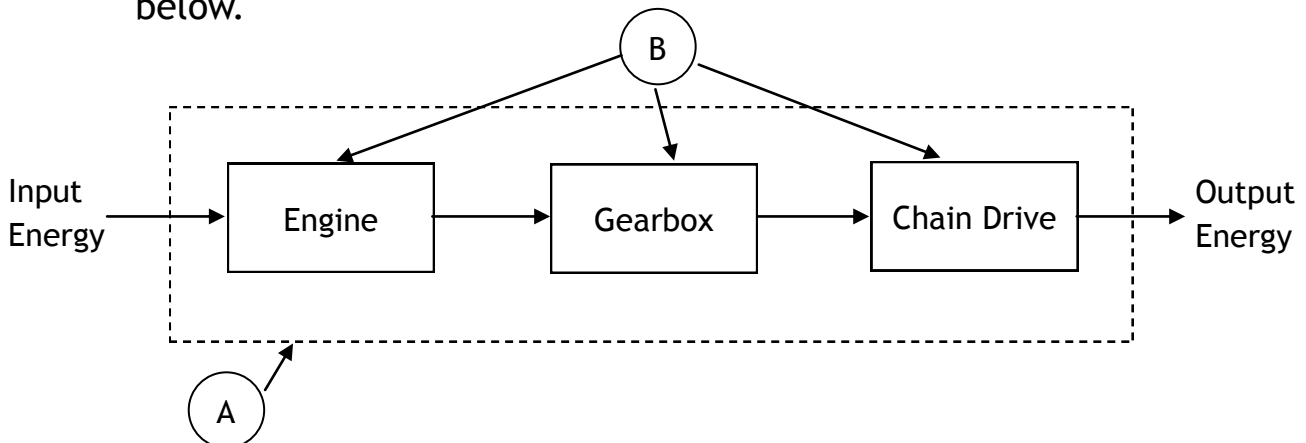
1. A petrol driven mini-moto is shown below.



- (a) Complete the system diagram below for the mini-moto by adding the main input energy and the main output energy.



- (b) The main parts of a mini-moto drive system are shown in the diagram below.



- (i) (A) separates the system from the outside world. State the name of this part of the diagram.
- (ii) The whole system can be broken down into several parts labelled above as (B). State the name given to these parts.

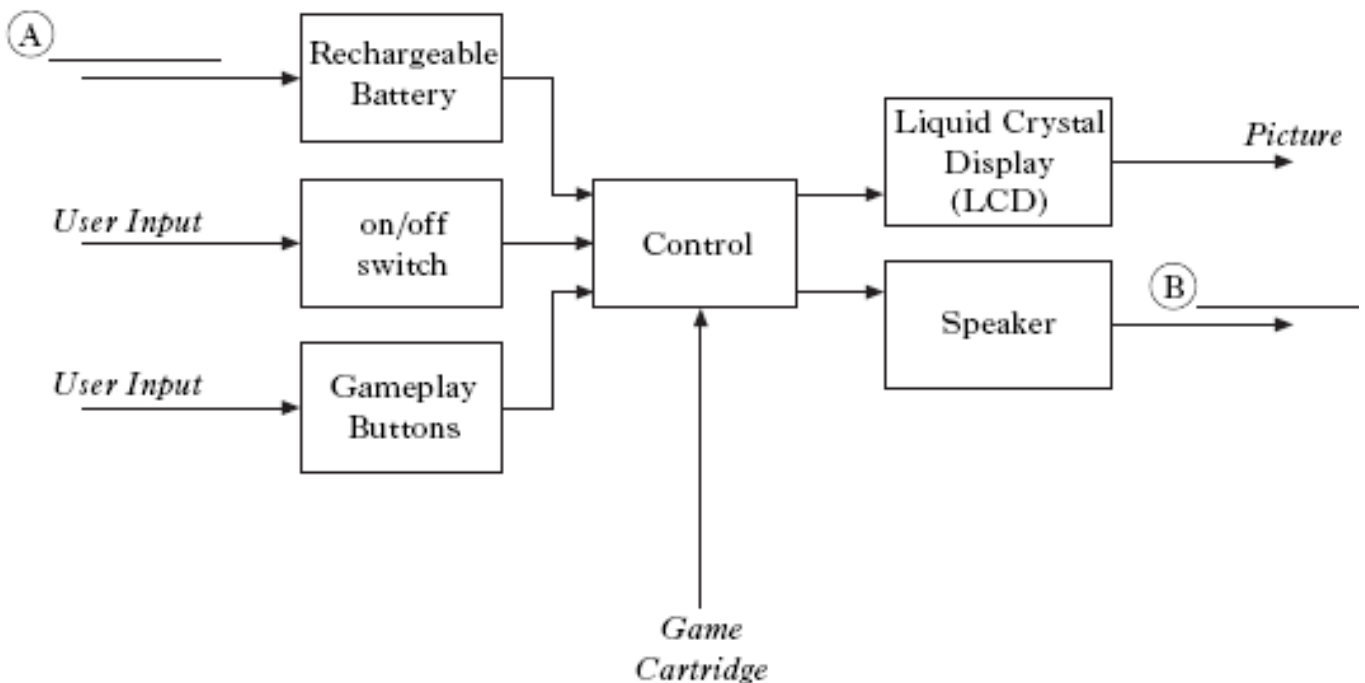
2. A hand held games console is shown.



A simplified diagram of the main parts of the games console is shown below.

(a) Complete the diagram by adding:

- (i) the missing input (A);
- (ii) output (B);
- (iii) the system boundary.

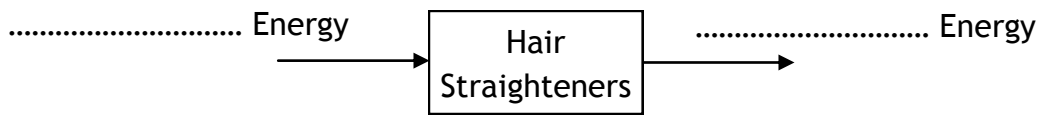


(b) The system consists of six parts shown above. These parts of the system are called _____.

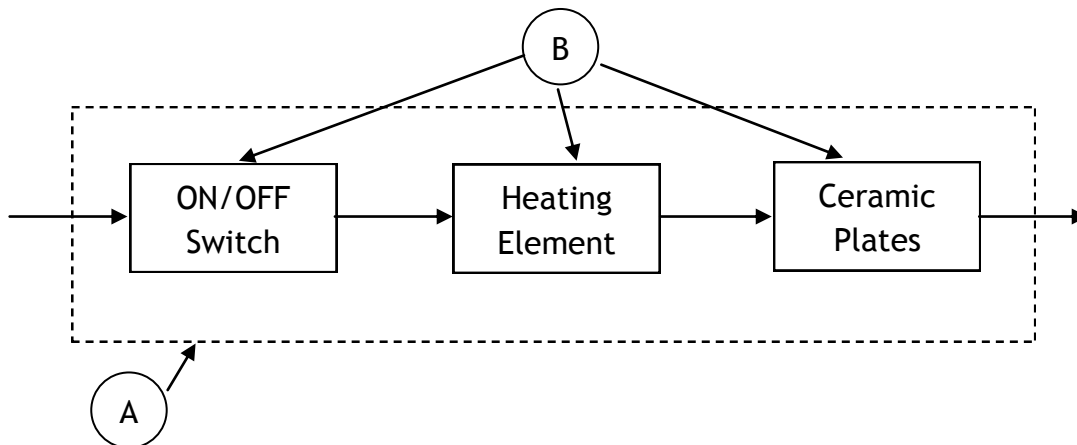
3. Hair straighteners are shown below.



(a) Complete the system diagram below for the hair straighteners by adding one main input energy and one main output energy.



(b) The main parts of the hair straighteners are shown below.



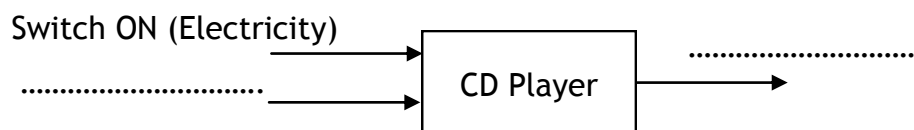
(i) (A) separates the system from the outside world. State the name of this part of the diagram.

(ii) The whole system can be broken down into several parts labelled above as (B). State the name given to these parts.

4. A CD player is shown below.



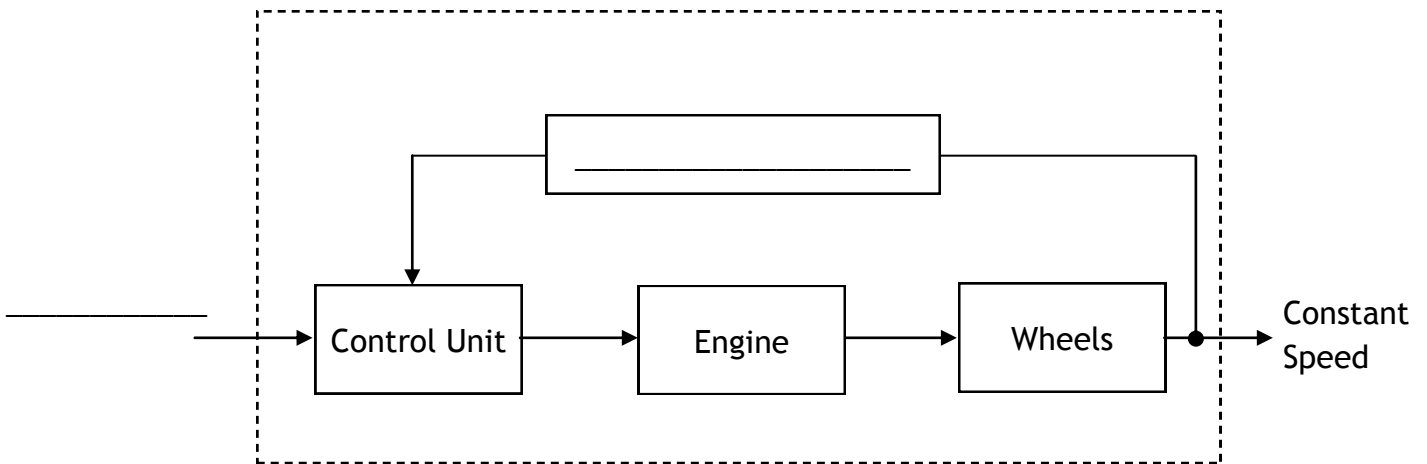
(a) Complete the diagram below for the CD player by adding one main input and one main output. One input has been provided for you.



(b) Draw the Universal System Diagram.

5. A manufacturer wants to use a cruise control system to keep a car's speed constant even when it goes up and down hills. The system should allow a driver to take their foot off the accelerator once the desired speed has been set.

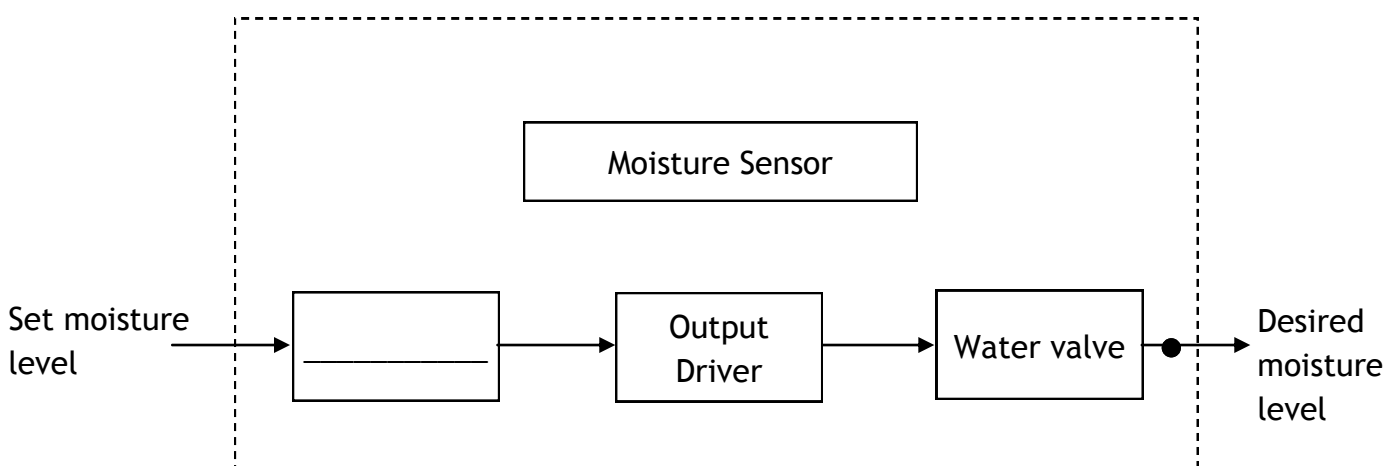
(a) Complete the diagram below for the cruise control system.



(b) This system makes use of a feedback loop. State the type of control produced by this automatic system.

6. The moisture level in a greenhouse is controlled automatically.

(a) Complete the diagram below.

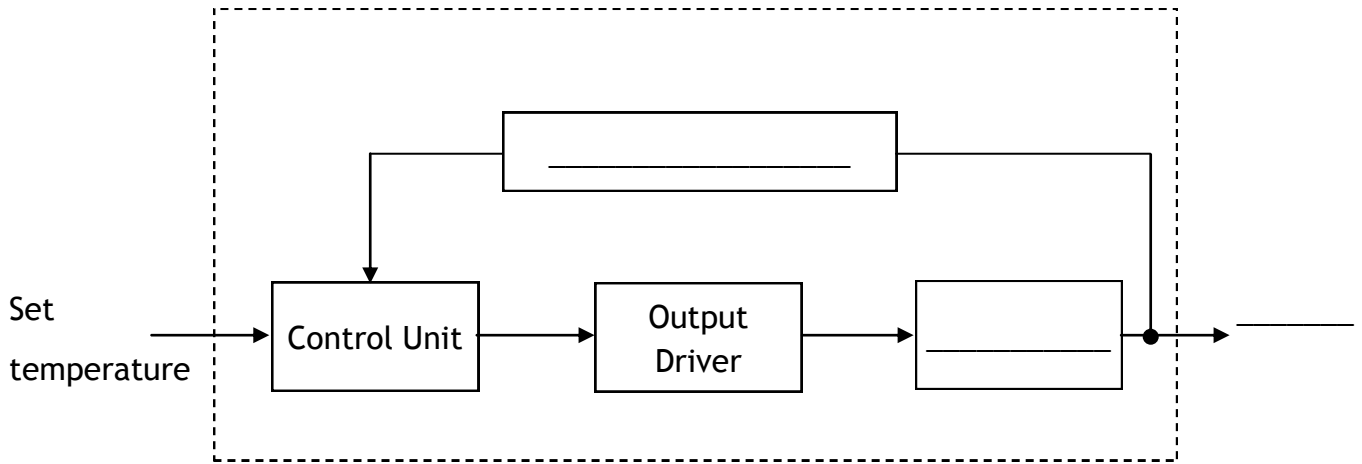


(b) State the type of control produced by this automatic system.

(c) State a suitable electronic device which could be used for the output driver sub-system.

7. An air conditioning system is operated by closed loop control.

(a) Complete the diagram below.



(b) State a suitable electronic component which could be used for the output driver sub-system.

8. The temperature of a steam room in a leisure centre is controlled automatically.

A valve opens to release steam when the temperature is below the set level. When the temperature of the room is hot enough, the valve is closed.

(a) State the type of control produced by this automatic system.

(b) Complete the diagram.

