



**Applications of microcontrollers in process control**

**Answer the following questions:**

Q1

20 degree

A level control system consists from; tank, pump, valve, heater, temperature sensor, low sensor, high sensor and start/stop switches. The system is controlled online using an ARDUINO UNO kit. When the user press the start switch, the sequence of operation is:

1. Turn on the pump until the level in the tank is reached to the maximum level.
2. Turn on the heater until the temperature reaches to  $70^{\circ}C$ .
3. Turn on the valve until the tank is empty.
4. Repeat the operation until the user press the stop switch.

Assume the temperature sensor has a transfer function;  $10mV/^{\circ}C$ .

**Determine the following:**

- A. The interface circuit that shows the inputs and outputs connections with ARDUINO UNO kit.
- B. The program flowchart that shows the operation of the system.
- C. An ARDUINO program.

Q2

20 degree

Design a control system using microcontroller to control the operation of a washing machine AC three phase motor in the two directions of rotation. The system is equipped with two normally open pushbuttons one for starting the operation, while the other is for stopping the system. When the start PB is pressed, the motor operates for 4 cycles then it is automatically stopped by the microcontroller.

Each cycle consists of four successive steps which are:

1. Rotation in the clockwise direction for 15 seconds.
2. Stopping for 5 seconds.
3. Rotation in the counterclockwise direction for 10 seconds.
4. Stopping for 4 seconds.

If the stop pushbutton is pressed at any instant, the motor must be immediately stopped.

**Determine the following:**

- A. The interface circuit that shows the inputs and outputs connections with ARDUINO UNO kit.
- B. The program flowchart that shows the operation of the system.
- C. An ARDUINO program.

**Q3**

**30 degree**

Design a control system for controlling the DC motor using PI controller (*discrete form*) where the motor supply is 12 V, sampling period is 0.01 sec., the proportional and integral gains are 1.5 and 0.5, respectively. The set-point is 300 rpm in clockwise direction for 60 sec.

**Note that:**

- The speed of the motor is measured using tacho-generator, which the transfer function has 1V/100 RPM.
- The design must include the following items:
  - A. The interface circuit that shows the inputs and outputs connections with ARDUINO UNO kit.
  - B. The program flowchart that shows the operation of the system.
  - C. An ARDUINO program.

*With my best wishes..... Dr. Eng. Ahmad M. El-Nagar*