UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: August 2022

Module Number: ME3211   **Module Name:** Principles and Applications of Microcontrollers

[Three Hours]

[Answer **all questions**; each question carries **10 marks**; provide neat sketches where necessary, and clearly state all assumptions you may make. Use the given information in figures 1-5 and tables 1-2 when answering questions. No need to mention the resistor values for fixed resistors in the constructed circuit diagrams. Use appropriate resistor values for the potentiometer]

Q1. a) Briefly describe the difference between a microprocessor and a microcontroller.

[1.0 Mark]

b) Briefly describe the operation of the below components inside a microcontroller.

   i.   Program memory

   ii. Data memory

   iii. Central Processing Unit (CPU)

   iv. Timers/ Counters

   v.   I/O Ports (I/O – Input/Output)

[5.0 Marks]

c) List two main components in the Central Processing Unit (CPU) and briefly describe the operation of them.

[4.0 Marks]

Q2. a) Explain the reason to use pull-up or pull-down resistors with switches connecting to microcontroller development boards.

[2.0 Marks]

b) Sketch the circuit diagram showing how to use a switch with one pull-up resistor.

[1.5 Marks]

Q2 continuous to the next page

c) Sketch the circuit diagram showing how to use a switch with one pull-down resistor.

[1.5 Marks]

d) Briefly describe the operation of the below components inside a microcontroller.

    i.   Watchdog timer

    ii.   System bus

    iii.   Volatile memory

[3.0 Marks]

e) Briefly describe the function of low-power sleep modes in microcontrollers.

[2.0 Marks]

Q3. a) A flow chart for a C programme is given in figure 1. Construct the C programme relevant to that.

[5.0 Marks]

b) You are asked to use a potentiometer as an input and an LED as an output with the microcontroller development board given in the figure 2.

    i.   Specify the input and output pins required for connecting the above circuit components. Give reasons for your selections.

    ii.   Construct a basic circuit diagram with the potentiometer as an input and the LED as an output. clearly label all the components and used pins.

[5.0 Marks]

Q4. a) You are asked to make a low-cost consumer device to turn on and turn off three light bulbs (230V AC) using the microcontroller development board shown in figure 2. Three switches are to be used to turn on and turn off each bulb manually (if one switch for one bulb). Once one of the switches is pressed, the respective bulb is turned on and turn off the same by the next press. Three potentiometers are used to control the ON duration of the each light bulbs separately. After that time, the bulbs will be turned off automatically.

    i.   Explain whether the interrupts in the given development board should be used in this low-cost project.

    ii.   Construct a C programme using the answer to the above. Indicate the purpose of each section of the code of the program as comments (begin by //).

[6.0 Marks]

b) Two student groups have given a task of making a distance measuring device using a microcontroller development boards shown in figure 2 and several ultrasonic sensors. This device is to be used to measure a fluid level from the overflow level of a tank. The fluid supply can be cut off when the fluid level is near the overflow level. One group came up with the device with one ultrasonic sensor, and the other came up with three ultrasonic sensors to measure the same distance. Explain what will be the best design for the situations given below.

    i.   Water tank level control

    ii.   Diesel tank level control

[4.0 Marks]

Q5. You are asked to make a cooling system for an important medical item. It includes water pumps operated by DC motors and controlled by the microcontroller development boards shown in figure 2. Two cooling paths need to be supplied with coolant, so a minimum of two pumps are required. The system should be reliable to supply coolant continuously and accurately control the motors' speed

a) Explain how many DC motors should be used as pumps for the cooling system.

[2.5 Marks]

b) Explain how many microcontroller development boards shown in figure 2 should be used to drive all DC motors. If there is to use more than one development board, explain the communication method to use between the boards.

[2.5 Marks]

c) Construct a basic circuit diagram for the design, clearly labelling all the used pins. Use a separate power supply for the motor power supply.
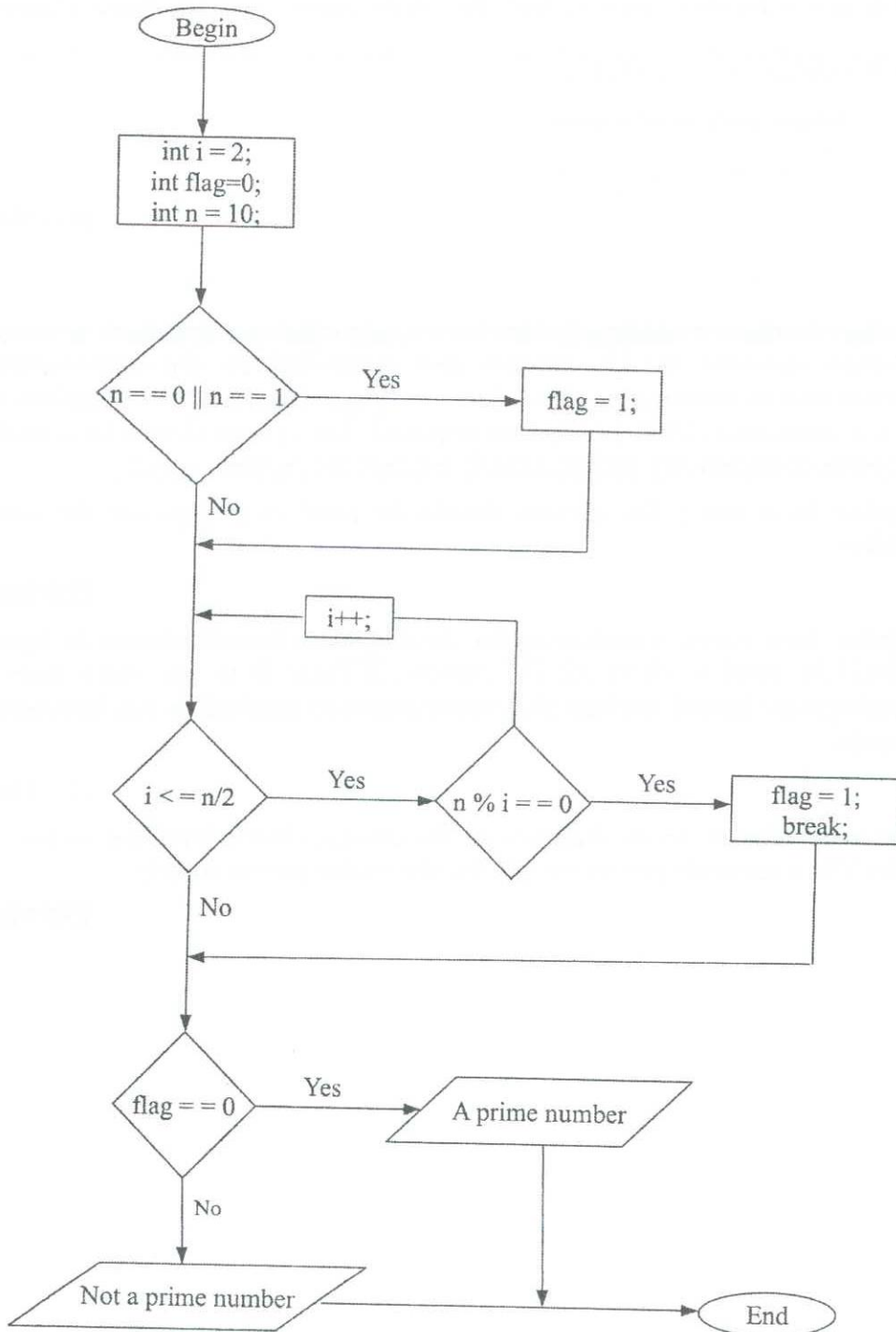
[5.0 Marks]
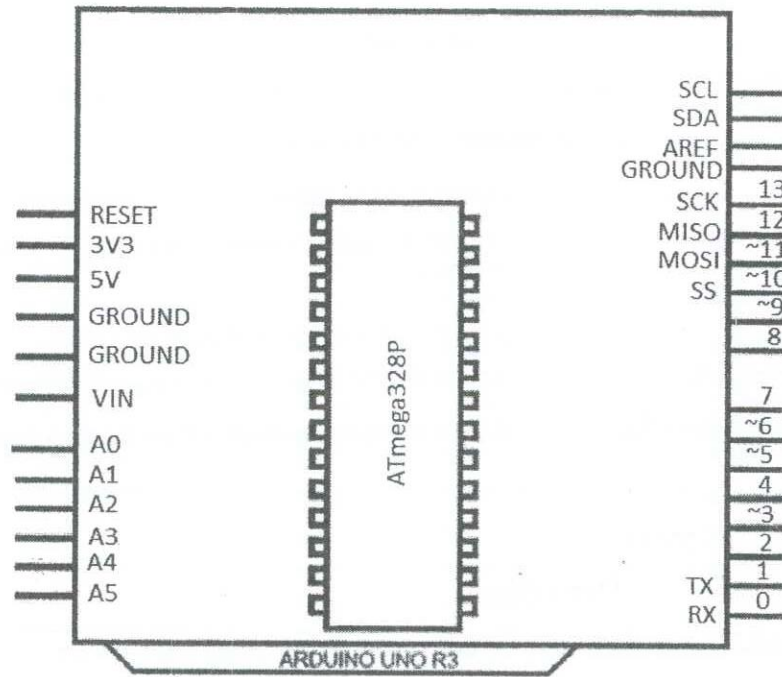
Annex

Figure 1: Flow chart
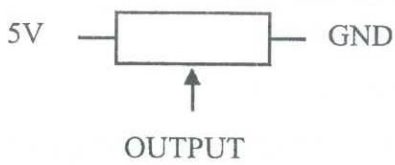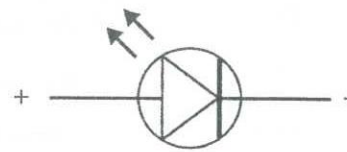
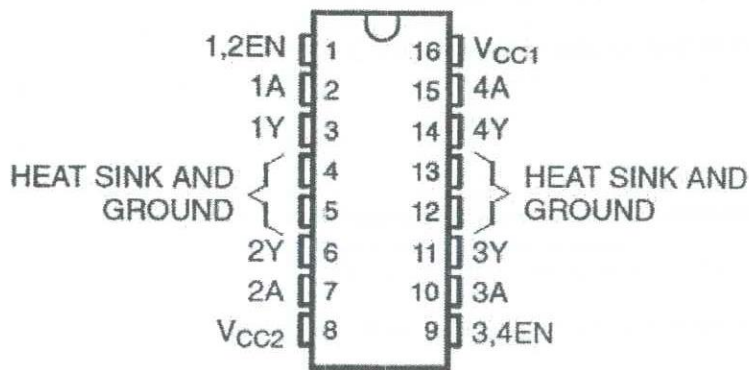Figure 2: Arduino UNO pin diagram

Figure 3: Potentiometer

Figure 4: LED

Figure 5: Pin diagram of the L293D motor driver

Figure 6: Resistor

Table 1: Useful C commands

For C language	
printf("Include here the required text output");	Give outputs from C language
For Arduino UNO board	
pinMode(trigPin, OUTPUT);	Define an output
digitalWrite(trigPin, LOW);	Write a digital value to an output (value = LOW)
delayMicroseconds(x);	Pause x number of micro seconds
analogWrite(pin number, i);	Get a PWM output. i is a number from 0 to 255
analogRead(pin number) *0.0049;	Get the input voltage of an analog input

Table 2: Pin description of L293D

Pin number	Pin name	Description
1	1, 2EN	This pin enables the input pins 1A and 2A.
2	1A	Directly controls the output pin 1Y.
3	1Y	Connected to one end of motor 1.
4	GROUND	
5	GROUND	
6	2Y	Connected to other end of motor 1.
7	2A	Directly controls the output pin 2Y.
8	Vcc_2	Connected to voltage pin for supplying running motors. (4.5 V to 36 V)
9	3, 4EN	This pin enables the input pins 3A and 4A.
10	3A	Directly controls the output pin 3Y.
11	3Y	Connected to one end of motor 2.
12	GROUND	
13	GROUND	
14	4Y	Connected to other end of motor 2.
15	4A	Directly controls the output pin 4Y.
16	Vcc_1	Connected to 5V to enable the IC function.