UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: July 2017

Module Number: ME 5311 **Module Name: Mechatronics and Embedded Systems**
[Three Hours]

[Answer **all questions**, each question carries ten marks]

Q1. a) State and briefly explain typical "Mechatronics system components".

[3.0 Marks]

b) Modern control systems leads to the Artificial Intelligence. State and explain the differences identified with classical control systems and modern control systems.

[3.0 Marks]

c) An AGV (Automated Guided Vehicle) carries manufactured products to a storing facility. The products are labeled with a sticker as RED, GREEN, BLUE and WHITE respectively to distinguish each item. Once the AGV reaches the storing facility, it has to place each item to the drawers painted in RED, GREEN, BLUE and WHITE by considering the colour of the item collected. A robot arm is used for this. It contains a colour sensor to observe the colours of the item it picks.

i) Sketch an appropriate design of the system and identify the critical processes.

ii) Draw a flow chart to support the design you propose.

iii) State the hardware components which have to be used to implement the proposed system

[4.0 Marks]

Q2. a) Modern computer programming uses IDE to support the developer's work in numerous ways.

i) State the components built into a typical IDE and briefly explain the functionality of each component giving necessary examples

ii) Explain the process define as "Compiling a Program" by highlighting its importance.

[4.0 Marks]

b) i) Categorize sensor types based on type of signal they accommodate and explain how they are to be interfaced with a signal conditioning device.

ii) Sketch a typical voltage divider circuit and demonstrate how the linear voltage variation occurs at a specified point in the circuit.

iii) Demonstrate how you would use Light Dependent Resistor as a light intensity meter and design a smart light intensity controller for home lighting.

iv) Explain how to overcome the problems arises with "Dead Band" and "Saturation" of a linear output sensor.

[6.0 Marks]

Q3. a) Briefly explain the terms ""Program counter" and "Memory Register" used in Microcontroller Units and identify their differences.

[2.5 Marks]

b) In computer controlled applications, there are many ways that the controller behaves abnormally. MCUs uses many different self-defense mechanisms to overcome these problems. The "Watchdog Timer" is a one such mechanism. Explain the functionality of Watchdog Timer using appropriate examples.

[2.5 Marks]

c) i) State and explain the advantages and disadvantages in using an MCU in automation.

ii) State the functionality of "SFR" used in embedded application development process.

[2.0 Marks]

d) i) Figure Q3 depicts the pin-out diagram of a PIC18F452 MCU. Sketch a MCU power-up circuit using the given pin-out diagram.

ii) In energy-harvesting applications, battery backup plays a critical role in maintaining power output when energy from ambient sources dwindles below useful levels. To maintain battery performance and safety, these applications need the ability to communicate battery status and fault states to central servers and operators. In particular, safe operation of battery stacks require careful monitoring to detect cell defects, shorts, and degradation that can cause batteries to fail. As an example, safety concerns associated with lithium-ion battery stacks are driving a need for continuous cell monitoring and rapid communication of faults and potential problems to human operators able to intervene before serious failures can occur.
Give a design for the above system and use a suitable Flow Chart and a Circuit Schematic to demonstrate it.

[3.0 Marks]

Q4. a) Table 01: Temperature conversion, on an 10-bit ADC of an application

i) Briefly explain the process "ADC".

ii) Design a suitable program flow chart for the above application.

iii) Write a suitable program to perform the designed process.

iv) Identify the types of "Transducers" which would most likely to be interfaced using this program.

[4.0 Marks]

b) A balancing system consists of an angle measurement sensor. The angle measurement sensor is providing a positive reading if the movement is in clockwise direction and it gives a negative reading for the anti-clockwise direction movement. The reading becomes zero for the horizontal position of the base plate of the system. The base plate movement can be controlled by a DC motor. If the measured movement of the plate is clockwise the

motor will rotate anti-clockwise and tolerate the movement. If it is opposite the motor will rotate clockwise to tolerate the movement. A MCU based controller has been developed for this. When the reading of the angle measurement sensor increases the counter movement has to be increased too. The reading of the angle measurement sensor will range from -20 degrees to +20 degrees.

i) Modify the program written in Q4 a) iii) to satisfy the requirement mentioned above.

ii) State the assumptions made in the process.

[3.0 Marks]

c) i) Explain the use of "Quadrature Encoder" in position control with necessary examples. Derive a flow chart for the above application

ii) For the above requirement the capability of using quadrature encoder is inappropriate. Do you agree with the above decision? Justify your answer with necessary arguments.

[3.0 Marks]

Q5. a) i) Identify the circuit components depicted for an Elevator control simulation using a pic microcontroller shown in Figure Q5 (a).

ii) Derive a flow chart for the above application

[2.0 Marks]

b) i) The program below to run two motors using PWM is incomplete.

```
void main() {
 TRISB = 0;
 TRISC = 0;
 PWM1_Init(5000);
 PWM2_Init(5000);
 PWM1_Start();
 PWM2_Start();
 PWM1_Set_Duty(255);
 PWM2_Set_Duty(255);
 while(1){
 }
}
```

Complete the program used in b) i) to run two motors clockwise 3 seconds and counter clock 2.5 seconds respectively.

ii) Write a "C" program to perform the task shown in Figure Q5 (a) typical applications of each type.

[2.0 Marks]

c) Figure Q5 (b) shows a traffic light system. Which is one of the fascinating applications of Embedded systems. The Figure Q5 (b) diagram illustrates the traffic flow layout of the four way road. And this is just a model of the four way road, schemes and layout may be subjected to change.
The traffic flow can be classified in to four phases in the above diagram and the North is considered as the starting point of this traffic flow. In the above scheme vehicles are allowed to make a free right turn so we need to consider only two directions straight and left. The green signal is classified into two

types one for G for permitting vehicle to proceed forward and GL for permitting vehicles to left.
The four phases are,

PHASE I-

Initially Vehicle from A needs to travel to F and from E to B roads.
So in the first Phase forward green signal in A and E permits vehicles to pass through while East and west roads are stopped by red signal.

PHASE II-

Phase II permits the vehicle to pass from G to D and from C to H roads. Traffic flows from rest of the two roads North and south was stopped by means of Red signal.

PHASE III-

Phase three permits traffic flow in the left directions from A to D and from E to H.
Traffic flow in East and west are stopped by means of red signal.

PHASE IV-

Phase four permits traffic flow from C to F and from G to B.
Traffic flow in the North and south are stopped by means of red signal.
The cycle repeats again from Phase I to Phase IV and thus the traffic is regulated.

i) Draw an appropriate flow chart to demonstrate four phases.

ii) Write a "C" program to fulfill the task.

[6.0 Marks]

Figure Q3

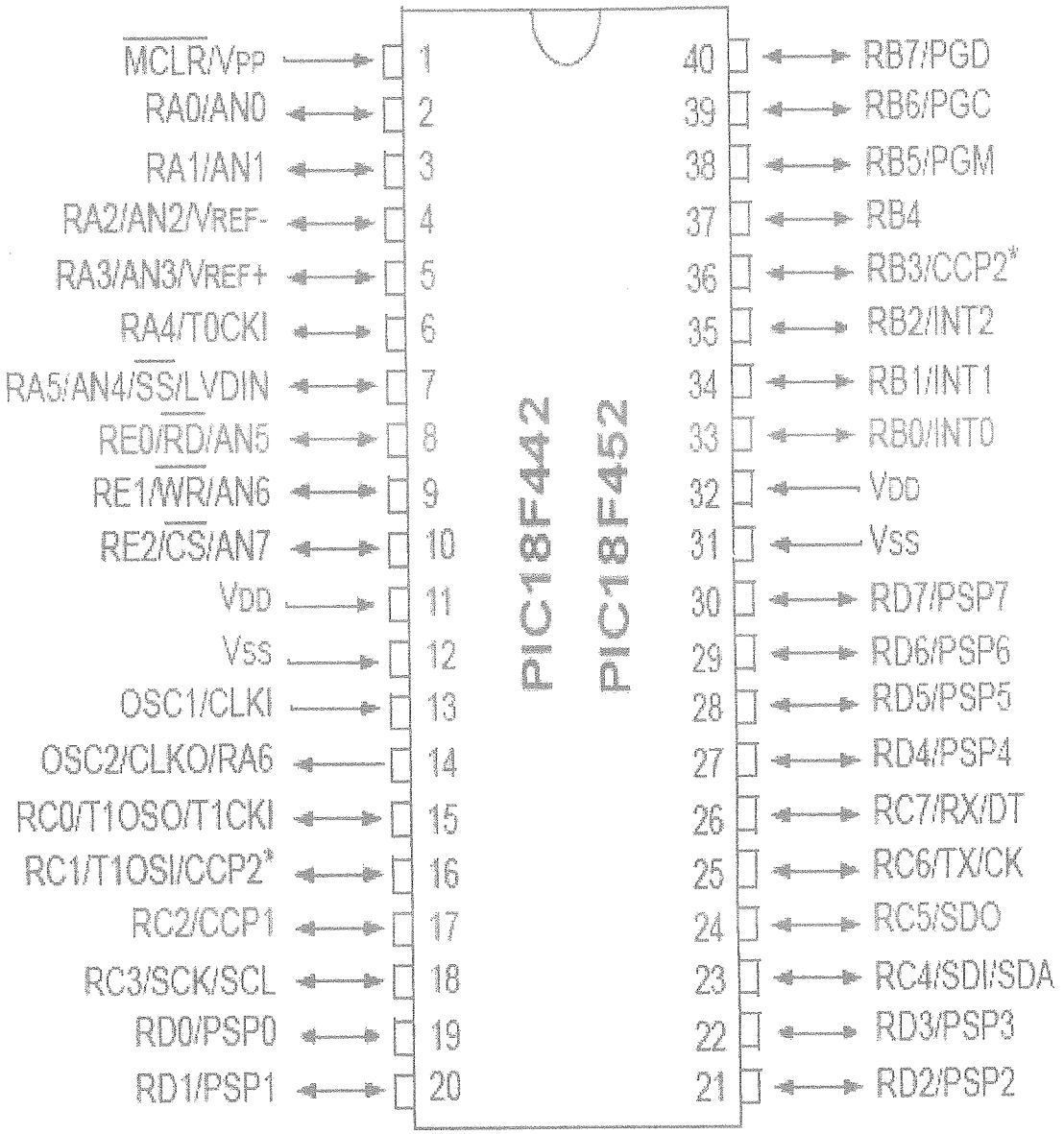

Table 01: Temperature conversion, on an 10-bit ADC

Bit:	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Volts:	2.5	1.25	0.625	0.3125	0.156	0.078	0.039	0.0195
Output Value:	0	0	1	0	1	1	0	0

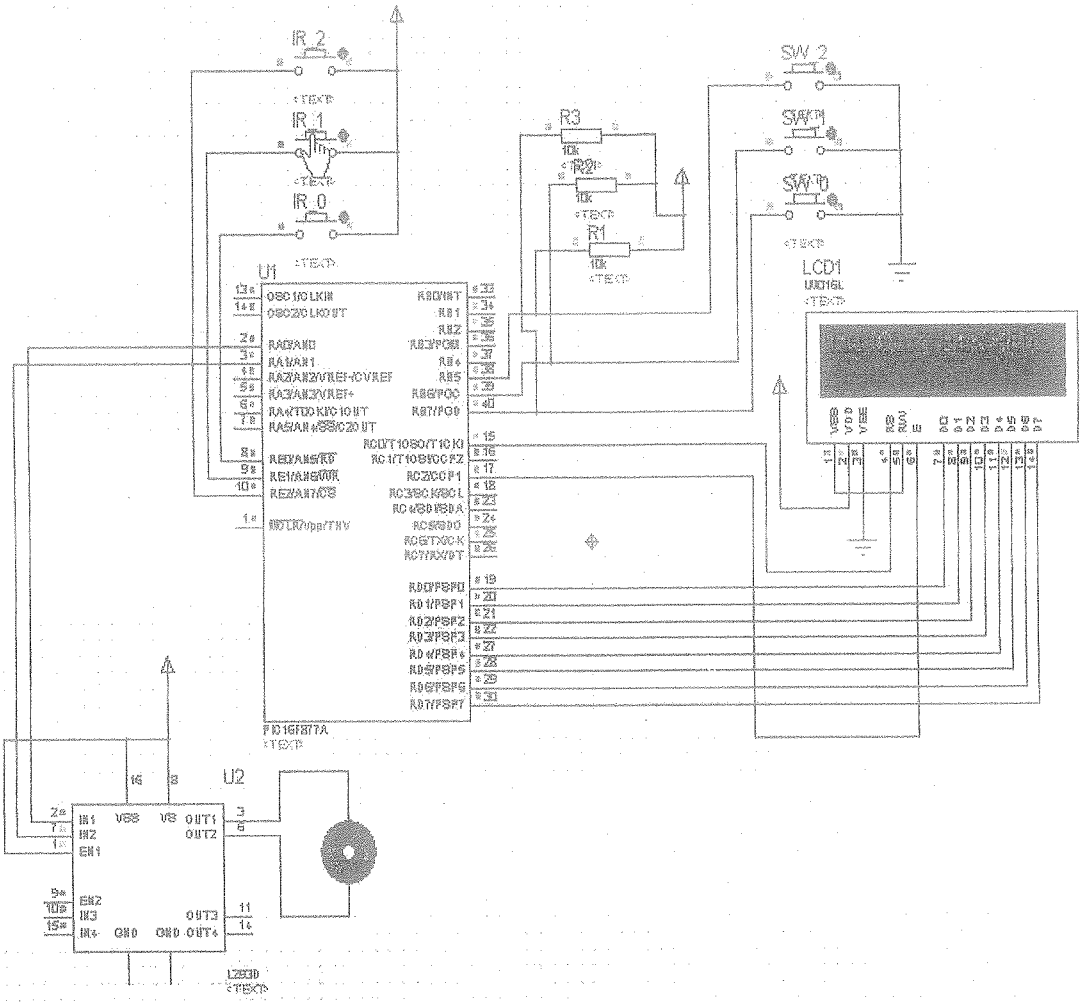

Figure Q5 (a)

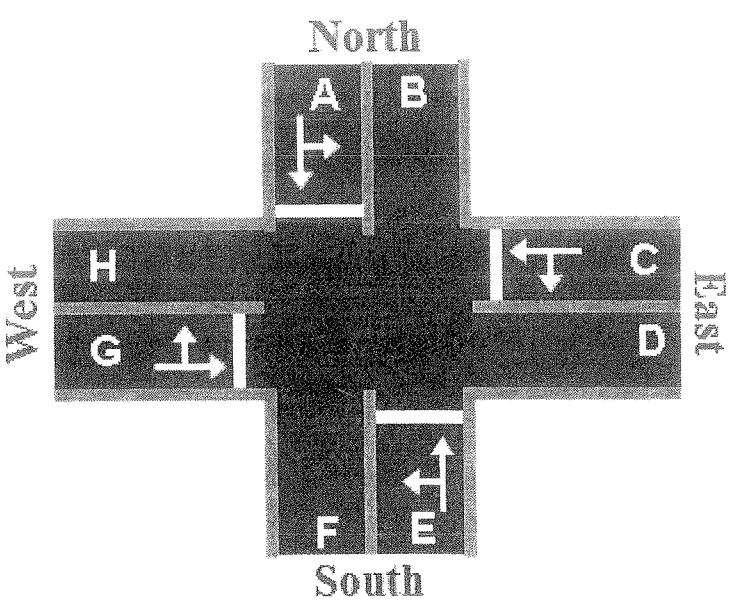

Figure Q5 (b)