UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: August/September 2018

Module Number: ME5311 **Module Name: Mechatronics and Embedded Systems**

[Three Hours]

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

Q1 a) Explain how Mechatronic Systems integrate to the modern manufacturing systems giving suitable examples.

[4.0 Mark]

b) Briefly explain the term "Embedded System".

[2.0 Mark]

c) A Front Office of a leading spa resort maintains a customer management system to provide a better service to their customers. From the Front Office they provide **two** main services. They are payments and customer care. Usually the first category includes 50 customers a day and the second includes 100 customer problems and issues a day at maximum demand. Once the customer approaches the front office they are issued a token. The token includes a customer reference number that is specific to service and they are called based on availability of the relevant support staff.

i) Identify and explain the key features required for the automation system.
ii) Implement the design process of the proposed system using a block diagram.

iii) State the hardware components you propose to use to implement this system.

[4.0 Mark]

Q2. a) Briefly explain the following terms.

i) Electro – Mechanical system integration
ii) Active and Passive Sensing.

[4.0 Mark]

b) i) Explain the term "Transducer".
ii) In a home automation system "Energy efficient lighting" is a very important feature. Identify an appropriate light intensity detector sensor for the system and justify your selection.
iii) Explain the advantages and disadvantages of the selected sensor.
iv) Demonstrate its application with a suitable circuit diagram.
(v) If the application also requires to install a temperature sensor to monitor the atmospheric temperature state the factors you would consider.

[6.0 Mark]

Q3 a) Explain the terms "interpreter" and "compiler" and identify the difference.

[1.5 Mark]

b) MCUs (Micro Controller Units) use many different self-defense mechanisms to overcome the problems caused by malfunctions. The "Watchdog Timer" is one such mechanism. Explain the functionality of a Watchdog Timer in an application.

[1.5 Mark]

c) i) Explain and distinguish the terms "SFR" and "UDR".
ii) State the advantages of "Library Files" used in embedded application development processes.

[3.0 Mark]

d) Figure Q3 illustrates the traffic flow layout of a four way road.

The traffic flow can be classified in to four phases as given below and it has considered the North as starting point of this traffic flow. And in the above scheme vehicles are allowed to make a free right turn so we need to consider only two directions straight and left. So the green signal was classified into two types one for **GF** for permitting vehicle to proceed forward and **GL** for permitting vehicles to left.

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 flow from rest of the two roads North and South are 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) Design a process flow chart for the above application.
ii) Develop the program for the above application.

[4.0 Mark]

Q4 a) The following program is written to communicate with a Analog sensor.

```
void Mains() {
 PORTB = 0a000000000;              //
 TRISB = 0a111110000;             //
//while(1) {
   PORTB =1;
Delay (1000);
   PORTB =0;
Delay (1000);
If(portb.f0==1)
Read_sensor[];
}
```

i) Explain the terms "TRIS" and "PORT".

ii) The above program supposed to read the state of a limit switch connected to RB5. State whether the above program is syntactically correct or not for this application. If incorrect make necessary corrections.

iii) Modify the program to read four limit switches and four indicators to represent the corresponding state of each limit switch placed on a chemical storage compartments for safety purposes.

[6.0 Mark]

b) Figure Q4 (a) shows a 40 pin midrange PIC MCU in an application. Develop a program to implement on this circuit schematic to complete the application. Consider that the input voltage is in the range of -3V to +3.3V.

[2.0 Mark]

c) The system in b) has to be coupled with another actuator to close an inflow in a tank. You may use an appropriate motor driver to be interfaced to operate the actuator. Extend your program to operate with the requirements mentioned.
You can find additional information in Figure Q4 (b).

[2.0 Mark]

Q5 a) i) Explain the term "Duty Cycle of PWM".

ii) Figure Q5 (a) depicts a motor driver chip. Compare the terms "Full H Bridge Motor Controlling" and "Half H Bridge Motor Controlling".

iii) State the type of motor controlling used by above chip in Figure Q5 (a).

[4.0 Mark]

b) i) An Automated Guided Vehicle's (AGV) drive system is designed based on the schematic on figure Q5 (b). Complete the design and write the program to drive the motors in forward for 20 Seconds and reverse for 10 Seconds

ii) State the advantages and disadvantages of using DC Motors for the above applications.

iii) State the alternatives can be used instead of DC Motors for the above application.

iv) Modify the program written and draw the design schematics to match the alternative/s suggested.

[6.0 Mark]

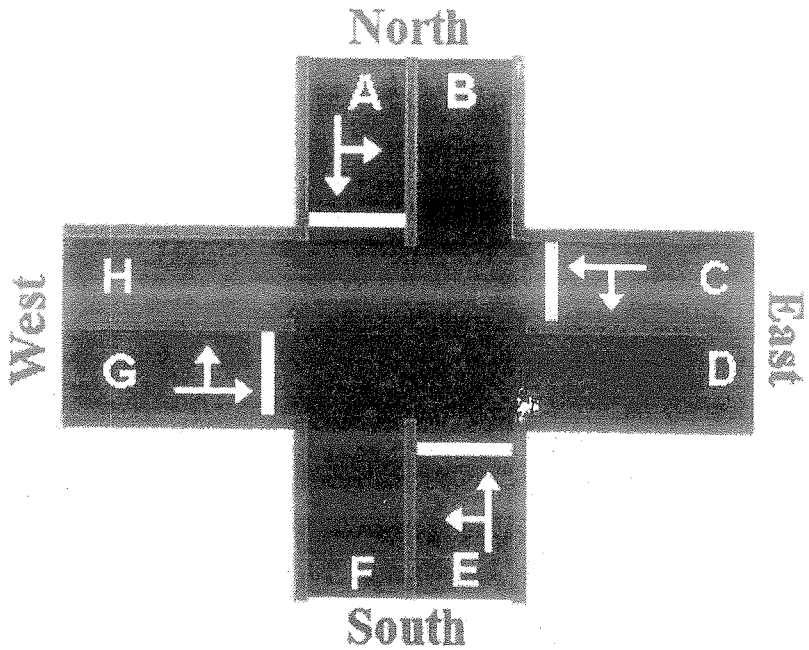

Figure Q3

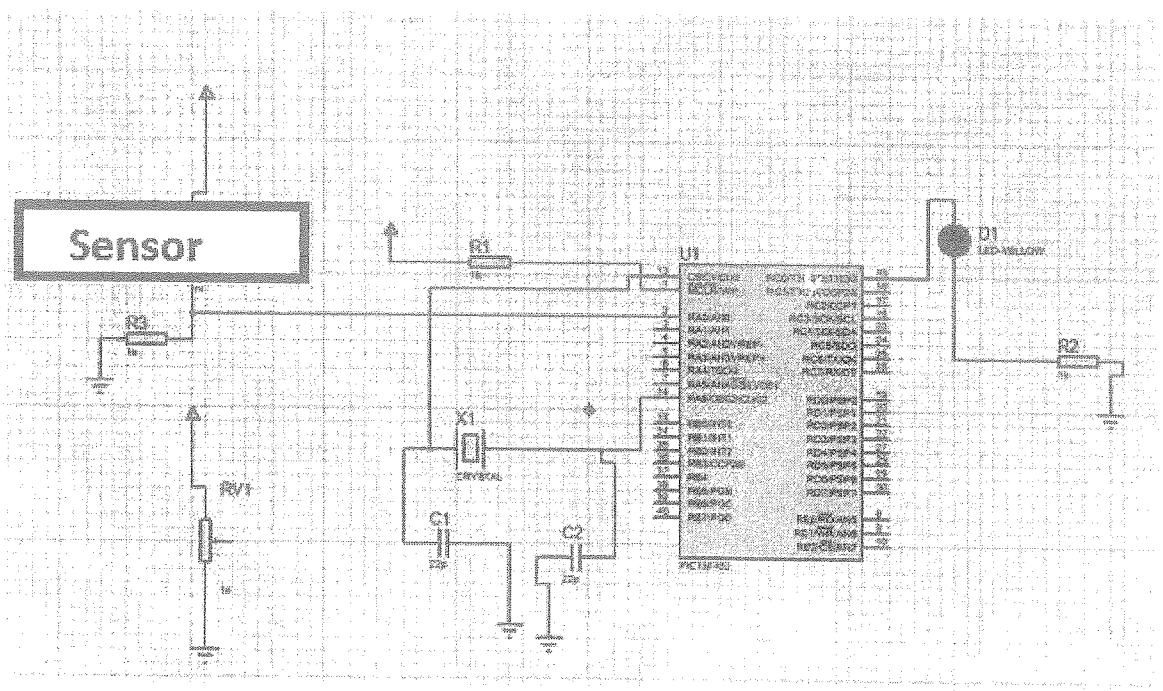

Figure Q4 (a)

REGISTER 17-2: ADCON1 REGISTER

R/W-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	ADCS2	—	—	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

bit 7 **ADFM:** A/D Result Format Select bit
1 = Right justified. Six (6) Most Significant bits of ADRESH are read as '0'.
0 = Left justified. Six (6) Least Significant bits of ADRESL are read as '0'.

bit 6 **ADCS2:** A/D Conversion Clock Select bit (ADCON1 bits in bold)

ADCON1 <ADCS2>	ADCON0 <ADCS1:ADCS0>	Clock Conversion
0	00	Fosc/2
0	01	Fosc/8
0	10	Fosc/32
0	11	FRC (clock derived from the internal A/D RC oscillator)
1	00	Fosc/4
1	01	Fosc/16
1	10	Fosc/64
1	11	FRC (clock derived from the internal A/D RC oscillator)

bit 5-4 **Unimplemented:** Read as '0'

bit 3-0 **PCFG3:PCFG0:** A/D Port Configuration Control bits

PCFG <3:0>	AN7	AN6	AN5	AN4	AN3	AN2	AN1	AN0	VREF+	VREF-	C / R
0000	A	A	A	A	A	A	A	A	VDD	VSS	8 / 0
0001	A	A	A	A	VREF+	A	A	A	AN3	VSS	7 / 1
0010	D	D	D	A	A	A	A	A	VDD	VSS	5 / 0
0011	D	D	D	A	VREF+	A	A	A	AN3	VSS	4 / 1
0100	D	D	D	D	A	D	A	A	VDD	VSS	3 / 0
0101	D	D	D	D	VREF+	D	A	A	AN3	VSS	2 / 1
011x	D	D	D	D	D	D	D	D	—	—	0 / 0
1000	A	A	A	A	VREF+	VREF-	A	A	AN3	AN2	6 / 2
1001	D	D	A	A	A	A	A	A	VDD	VSS	6 / 0
1010	D	D	A	A	VREF+	A	A	A	AN3	VSS	5 / 1
1011	D	D	A	A	VREF+	VREF-	A	A	AN3	AN2	4 / 2
1100	D	D	D	A	VREF+	VREF-	A	A	AN3	AN2	3 / 2
1101	D	D	D	D	VREF+	VREF-	A	A	AN3	AN2	2 / 2
1110	D	D	D	D	D	D	D	A	VDD	VSS	1 / 0
1111	D	D	D	D	VREF+	VREF-	D	A	AN3	AN2	1 / 2

A = Analog input D = Digital I/O
C/R = # of analog input channels / # of A/D voltage references

Figure Q4 (b)

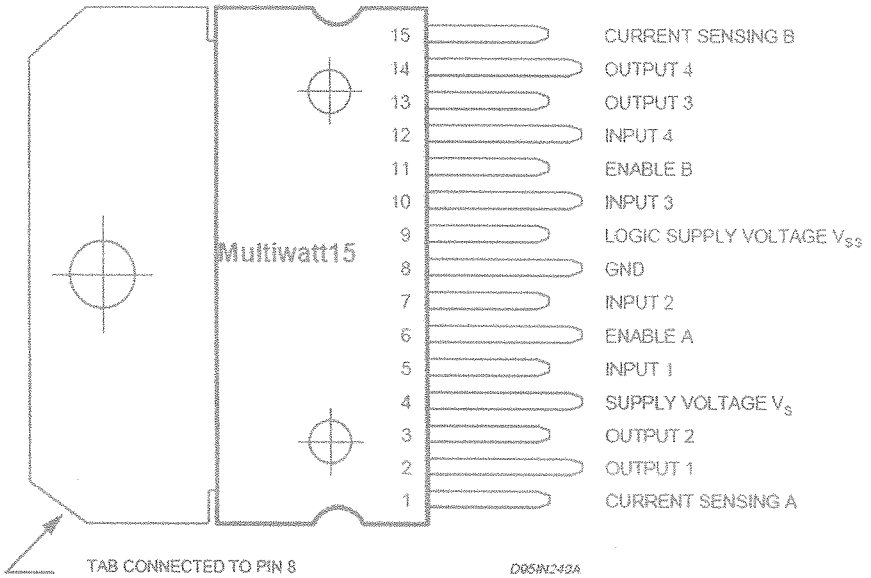

Figure Q5 (a)

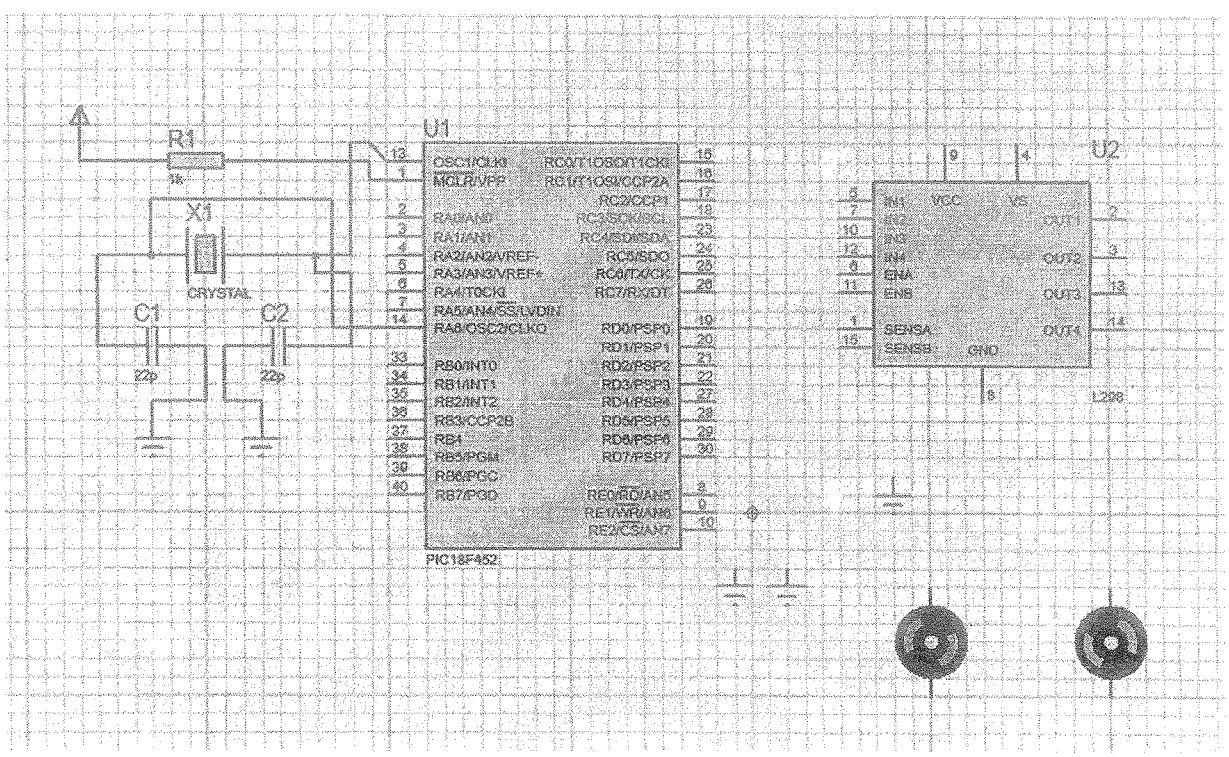

Figure Q5 (b)