UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: July 2016

Module Number: ME 5311 **Module Name: Introduction to Mechatronics**

[Three Hours]

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

Q1. a) Mechatronic systems are widely used in today's manufacturing applications in a large scale. By giving appropriate examples, explain the "Mechatronic System".

[2.0 Marks]

b) Briefly explain the term "Automation".

[2.0 Marks]

c) An Automation system is to be implemented to work with a conveyor system to be used for packing and labeling boxes of tea. The system contains three stages. In the first stage the system should recognize an entrant. Then the conveyor starts transporting the box. When it approaches the labeling zone the conveyor stops and a robot arm places the label. This operation takes approximately 30 seconds. After 30 seconds the conveyor starts moving the box and once it approaches the collecting area a robot arm collects the box and packs it in a container.

i) State the sensors and actuators required to develop the automated conveyor belt.

ii) Implement the above system by using a MCU and identify the key functions of the system.

iii) Draw a flow chart to demonstrate the implementation of the above system.

[6.0 Marks]

Q2. a) Briefly explain the following terms.

i) "Interpreter" and "Compiler" and identify the differences.

ii) Digital Input and Outputs in MCU applications.

[4.0 Marks]

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

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

iii) In a home automation system, "Fire Detection" is a very important feature. A possible way to identify the fire is the use of a light intensity detector. Identify an appropriate light intensity detector sensor for the application and justify your selection.

iv) Demonstrate application with the aid of a circuit diagram.

[6.0 Marks]

Q3. a) Briefly explain the terms "Registers" and "Keywords" and identify their differences.

[3.0 Marks]

b) The MCU of a control system could also sometimes indicate abnormal behavior when they meet extremes of their capabilities. In such conditions MCLR plays a main role. Explain what is MCLR and its functionality.

[2.0 Marks]

c) i) State and explain the advantages and disadvantages in using an external oscillator in Embedded Applications.

ii) State advantages of "Library Files" used in embedded application development process.

[2.0 Marks]

d) i) Figure Q3 (a) depicts the pin-out diagram of a PIC18F452 MCU. Identify the peripheral pins and state their functionality.

ii) The Figure Q3 (b) depicts the configuration bits of ADCON1 Register. Three humidity sensors attached to a food processing chamber has output voltages varying from -1.5V to +3.5V. Write a C programme to read the analog voltages.
Hint: Use the Table attached in Figure Q3 (b).

[3.0 Marks]

Q4. a) The following program is written to communicate with a particular type of a device.

```
void Mains() {
 PORTB = 0;            //
 TRSB = 1          //
while(1) {
//if(portd.f5=1){
   PORTB =1;
Delay (1000);
}
Else{
   PORTB =0;
Delay (1000);
}
}
```

State whether the above program is syntactically correct or not. If it is incorrect, then correct it.

[2.0 Marks]

b) Figure Q4 demonstrate a Full H-Bridge driver. Explain the use of a Full H-Bridge Circuit with examples

[2.0 Marks]

c) A dividing head of a rotary tool is required to maintain high precision and high accuracy in order to fabricate a critical component of a high end product

i) Briefly explain the terms "Precision" and "Accuracy".

ii) Explain the use of "Quadrature Encoder" in position control with necessary examples.

iii) 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.

[6.0 Marks]

Q5. a) i) Identify the devices depicted in Figure Q5 (a) and Figure Q5 (b) and briefly explain its applications.

ii) State the main limitation of the above sensors and state the appropriate alternatives.

[4.0 Marks]

b) i) Briefly explain the term "PWM".

b) ii) The programme 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){
 }
}
```

iii) Modify the above programme to run two motors clockwise for 3 seconds and counter clockwise for 2.5 seconds respectively.

ii) Compare and distinguish the use of DC Motor and Stepper Motor using a typical applications of each type.

[3.0 Marks]

c) i) RC Servo Motors have an in built "Closed Loop" control system. State the advantage these motors for position control of a particular rotary actuator.

ii) State the disadvantages of RC Servo Motors.

[3.0 Marks]

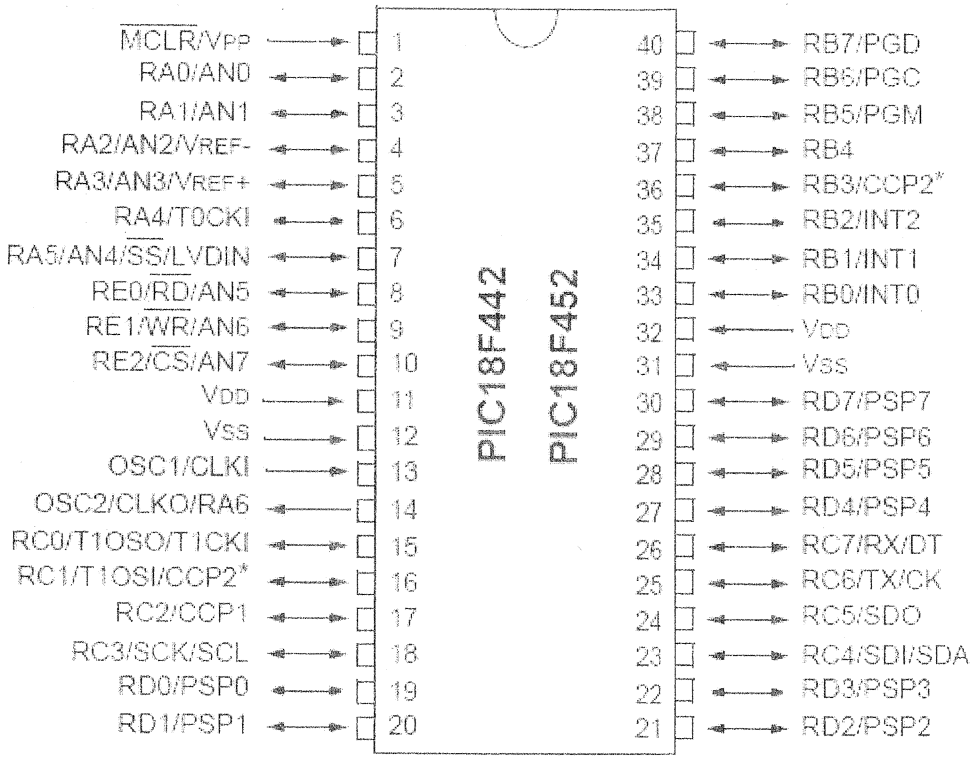
PIC18F442
PIC18F452
MCLR/VPP 1
RA0/AN0 2
RA1/AN1 3
RA2/AN2/VREF- 4
RA3/AN3/VREF+ 5
RA4/T0CKI 6
RA5/AN4/SS/LVDIN 7
RE0/RD/AN5 8
RE1/WR/AN6 9
RE2/CS/AN7 10
VDD 11
VSS 12
OSC1/CLKI 13
OSC2/CLKO/RA6 14
RC0/T1OSO/T1CKI 15
RC1/T1OSI/CCP2* 16
RC2/CCP1 17
RC3/SCK/SCL 18
RD0/PSP0 19
RD1/PSP1 20
40 RB7/PGD
39 RB6/PGC
38 RB5/PGM
37 RB4
36 RB3/CCP2*
35 RB2/INT2
34 RB1/INT1
33 RB0/INT0
32 VDD
31 VSS
30 RD7/PSP7
29 RD6/PSP6
28 RD5/PSP5
27 RD4/PSP4
26 RC7/RX/DT
25 RC6/TX/CK
24 RC5/SDO
23 RC4/SDI/SDA
22 RD3/PSP3
21 RD2/PSP2

Figure Q3 (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 Q3 (b)

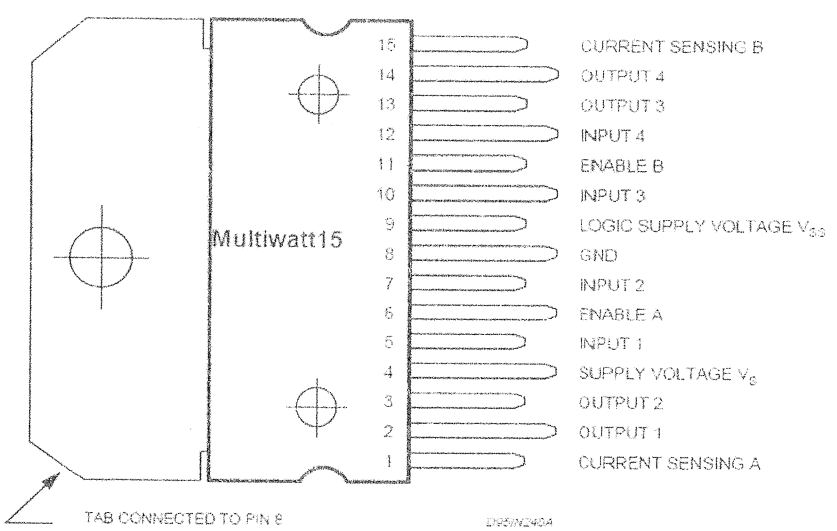

Figure Q4

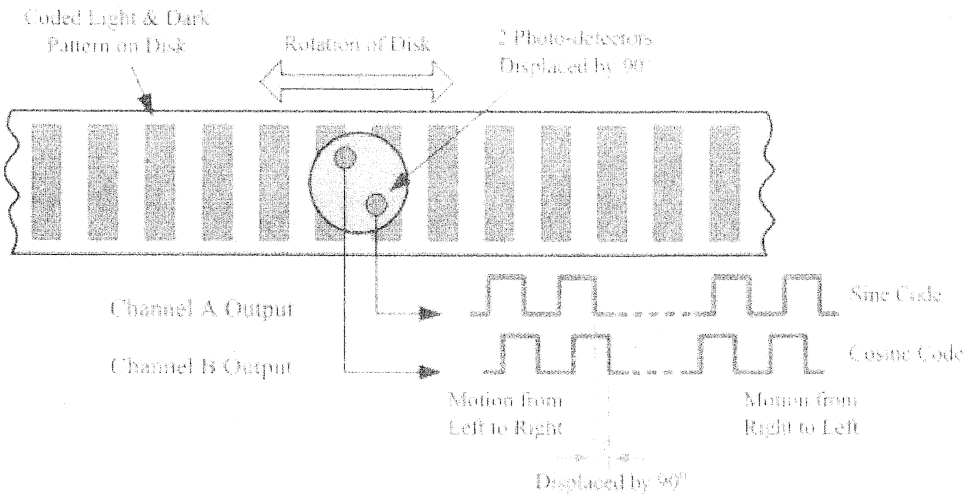

Figure Q5 (a)

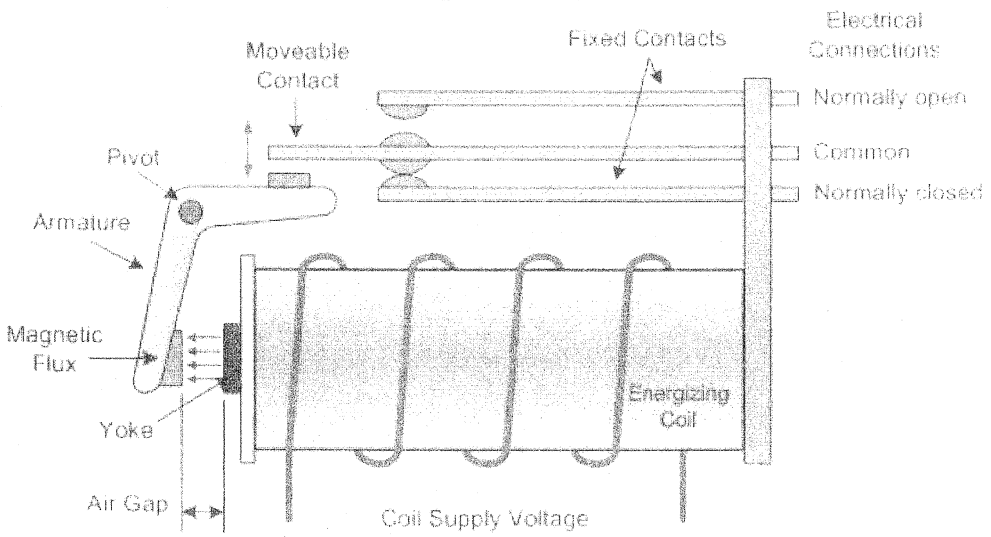

Figure Q5 (b)