# UNIVERSITY OF RUHUNA

**Faculty of Engineering**

End-Semester 5 Examination in Engineering: August 2015

**Module Number: ME5311** **Module Name: Introduction to Mechatronics**

**[Three Hours]**

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

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

[4.0 Marks]

b) Briefly explain the term "MCU".

[1.5 Marks]

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 each category and they are called based on availability of the relevant support staff.

i) Design an automated customer management system for the above purpose using a MCU, sketch an appropriate design of the system and identify the critical processes.

ii) Briefly explain each of these critical processes.

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

[4.5 Marks]

Q2. a) Briefly explain the following terms.

i) IDE.

ii) "Program counter" in MCUs.

[3.0 Marks]

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

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

iii) In a home automation system "Energy efficient lighting" is a very important feature. Identify an appropriate light intensity detector sensor for the above applications and justify your selection.

iv) Demonstrate its application with a circuit diagram.

[5.0 Marks]

c) State the importance of "Comments" used in a program by giving necessary examples and classifications.

[2.0 Marks]

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

[3.0 Marks]

b) In Computer Controlled Applications there are many ways that the controller behaves abnormally. MCUs (Micro Controller Units) use many different self-defense mechanisms to overcome these problems. The "Watchdog Timer" is one such mechanism. Explain the functionality of a Watchdog Timer in an application.

[2.0 Marks]

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

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

[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) Figure Q3 (b) depicts the configuration bits of an ADCON1 Register. Briefly explain the procedure to define four analog inputs and voltages of +3V to -1V outputs from four temperature sensors attached to a chemical reactor.

[3.0 Marks]

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

```
void Mains() {
 PORTB = 0;              //
 TRISB = 1              //
//while(1) {
   PORTB =1;
Delay (1000);
   PORTB =0;
Delay (1000);
Read_sensor[];
}
```

i) State whether the above program is syntactically correct or not.

ii) If incorrect, correct them.

iii) Identify the types of "Transducers" that would most likely be interfaced using the program.

[4.0 Marks]

b) Modify the above program to be used with a water level indicator. The water level indicator consists of an analog sensor panel and three LEDs for indicating **Top, Middle** and **Bottom** levels respectively. The analog sensor panel outputs an analog voltage equivalent to 5V dc at the highest water level and 0V dc at the lowest water level. The sensor value reading behaves linearly in this full span.

You may use any programming platform.

[4.0 Marks]

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 may find additional information in Figure Q4.
You find the following code segment helpful to develop your program.

```
void loop(){
analogWrite (pwm_pin,pwmvalue);
}
```

[2.0 Marks]

Q5 a) i) Identify the sensor depicted in Figure Q5 and briefly explain its applications.

ii) Label the sensor in Figure Q5 using appropriate terms.

iii) State the main limitation of this sensor and state appropriate alternatives.

[3.0 Marks]

b) i) The following program demonstrates a certain type of motor controlling protocol. State that protocol and briefly explain it.

```
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){
 }
}
```

ii) The above fragment of the code is to be used to drive two motors in the same direction. Complete the program using MikroC or Arduino to achieve this task.

iii) A control system has to be implemented to work with a conveyor system which is being used for packing and labeling boxes of tea. The system contains three stages. In the first stage the system should recognize an entrant, in the next stage the conveyor starts transporting the box and in the third stage when the box 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.
Identify and state the critical processes and sketch a flow chart to support your idea.

[4.0 Marks]

c) i) Name appropriate examples of "Active Sensors" and "Passive Sensors"

ii) Explain the function of position control using an "Encoder" sensor.

iii) Compare "Quadrature encoder" and "Absolute Position Encoders".

[3.0 Marks]

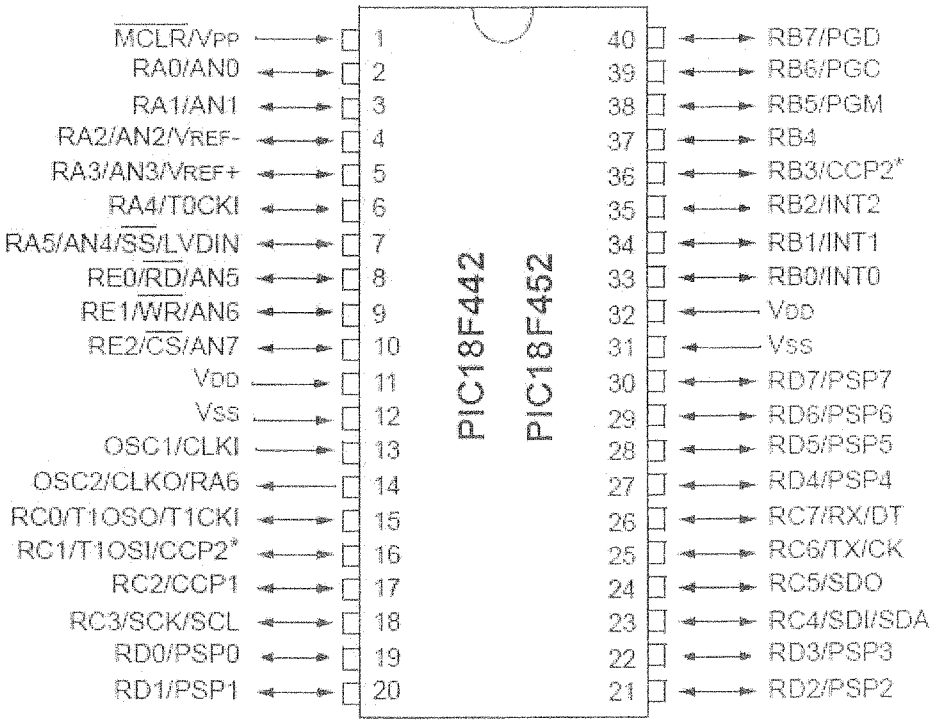
PIC18F442
PIC18F452
MCLR/VPP 1
RA0/AN0 2
RA1/AN1 3
RA2/AN2/VREF- 4
RA3/AN3/VREF+ 5
RA4/T0CKI 6
RA5/AN4/SS/LVDIN 7
RE0/RD/AN5 8
RE1/WR/AN6 9
RE2/CS/AN7 10
VDD 11
VSS 12
OSC1/CLKI 13
OSC2/CLKO/RA6 14
RC0/T1OSO/T1CKI 15
RC1/T1OSI/CCP2* 16
RC2/CCP1 17
RC3/SCK/SCL 18
RD0/PSP0 19
RD1/PSP1 20
40 RB7/PGD
39 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)

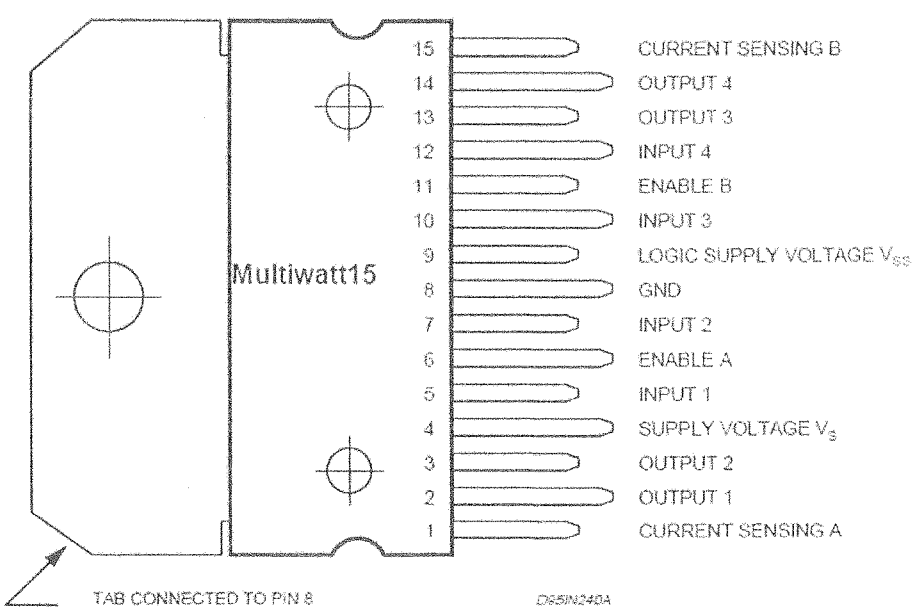


Figure Q4

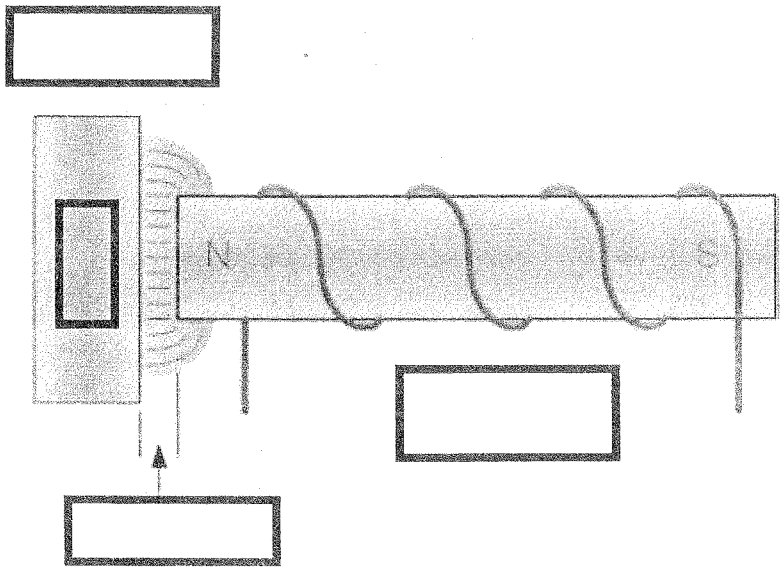


Figure Q5