UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: September 2014

Module Number: ME 5328 **Module Name: Introduction to Mechatronics**

[Three Hours]

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

Q1. a) The concept of "Automation" has become a dominant component in Research and Development (R & D) in today's manufacturing industry. Explain the way it has evolved over the years by stating the major contributions that has led to it.

[3.0 Marks]

b) Briefly explain the term "Signal" by giving examples.

[2.0 Marks]

c) A material handling system consists of an AGV (Automated Guided Vehicle). The AGV has to move from one place to another for loading and unloading the items it carries. Figure Q1 depicts the movements. When the start switch is switched "ON", the AGV has to move from left to right and vice versa. When the LS2 (Limit Switch 2) is triggered, the AGV stops and remains there for 5 seconds to load the items and then moves back to "HOME" position. When LS1 (Limit Switch 1) is triggered, the AGV stops and waits there for unloading and then for the start signal.

i) Develop a control system the above process by using a Microcontroller Unit (MCU). Draw a flowchart and explain critical processes of the control system.

ii) Briefly explain the major functions of the above process.

iii) State the hardware components necessary to implement the above process.

iv) Select a suitable MCU platform and write control program including an algorithm which is able to perform the above task.

[5.0 Marks]

Q2. a) Briefly explain the following terms.

i) Pulse Width Modulation (PWM).

ii) Registers in MCUs.

[3.0 Marks]

b) i) Explain how you can interface at least two major types of sensors with a MCU by giving suitable examples.

ii) If the sensor characteristics behave linearly, it is always preferred to that of its counterpart non-linear behavior. Do you agree with this statement?

iii) If so, justify your answer with suitable examples.

[5.0 Marks]

c) State the built in features in "IDE" and briefly explain the function of each.

[2.0 Marks]

Q3. a) i) MikroC and Arduino are two control algorithm implementation platforms. State their similarities and differences.

ii) The following program outputs a square waveform from RB1 (a notation uses to identify an input output pin) and contains several errors. Identify the errors in the program and correct them.

```
Void main () {
 PORTB = 0;            //
 TRIS = 1            //

while(2) {
   PORTB =1;
Delay(1000);
   PORTB =0;
Delay(1000);
}
}
}
```

[3.0 Marks]

b) Modify the above **corrected** program to blink four LEDs one after another going forward and backward for 20 times repetitively.

[2.0 Marks]

c) i) Explain the advantages and disadvantages in the use of a Micro Controller Unit in system automation.

ii) State the advantages of "Comments", used in embedded application's programing process.

[3.0 Marks]

d) The Library or Header files in programs serve the developer in different ways. Explain this with relevant examples.

[2.0 Marks]

Q4. a) State the main types of DC motors available and state their corresponding usages in industrial applications.

[2.0 Marks]

b) A DC motor controller has to be integrated with a speed senor. The sensor should be capable of measuring both speed and direction. Propose a suitable sensor and describe its functionality relevant to the above application.

[3.0 Marks]

c) A control system has to be implemented to work with a temperature control unit which is being used for chemical reactor cooling. The system contains three stages. First stage, the system should recognize the normal function of the reactor, second a temperature rise and third a temperature fall. The temperature is measured by an analog temperature sensor. The temperature in Normal function varies from 200 ^{0}C to 500 ^{0}C. The appropriate set temperature inside the reactor is 300 ^{0}C and at this point the motor fan runs at half of its maximum speed. When the temperature rises, a proportional controller has to be integrated to increase the fan speed to cool the system down to the set temperature (300 ^{0}C). The proportional gain to control the fan speed (k_{p1}) at this stage is 10.00. When the temperature falls, the particular proportional gain to control the fan speed (k_{p2}) is estimated at 4.00. Also you need to add three

indicators to let the operator be aware of the system condition and running-states.

i) Propose a suitable temperature sensor using a voltage divider circuit for the above application.

ii) Draw a schematic diagram of the system.

iii) Write a program to execute the above mentioned task using an Arduino MCU based platform as the controller.

You will find the following code segment helpful to develop your program.

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

[5.0 Marks]

Q5. a) i) Explain the terms "Active Sensors" and "Passive Sensors".

ii) Identify the transducer shown in Figure Q5 (a) and explain its functionality based on the given figure.

[3.0 Marks]

b) i) State the common position sensor types and give examples.

ii) A position sensor is required to detect tiny metal particles that can exist in a Biomedical product. State the most appropriate sensor you would select and justify your selection.

[3.0 Marks]

c) i) State and explain the types of major temperature sensors.

ii) The thermistor depicted in Figure Q5 (b) has a resistance value of 20 kΩ at 25 °C and a resistance value of 200 Ω at 200 °C. Calculate the voltage drop across the thermistor and hence its output voltage (V_{out}) for both temperatures when connected in series with a 1 kΩ resistor across a 12 V power supply.

iii) Briefly explain the main advantage of a Thermistor sensor over other thermocouple sensors.

[4.0 Marks]

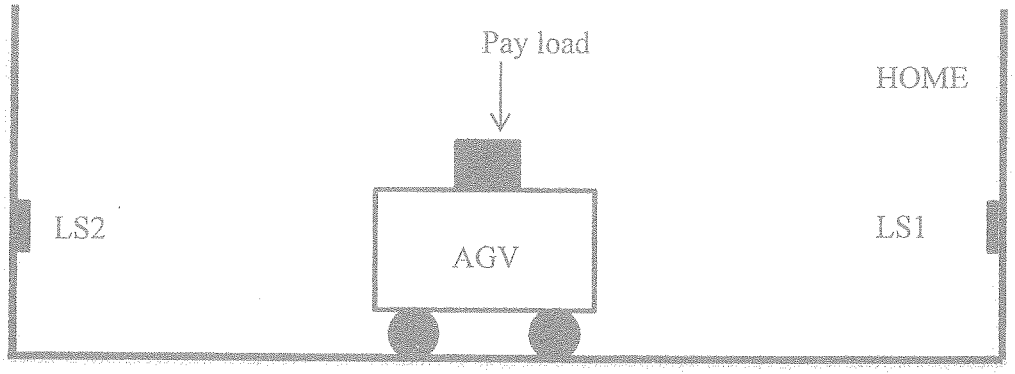

Figure Q1

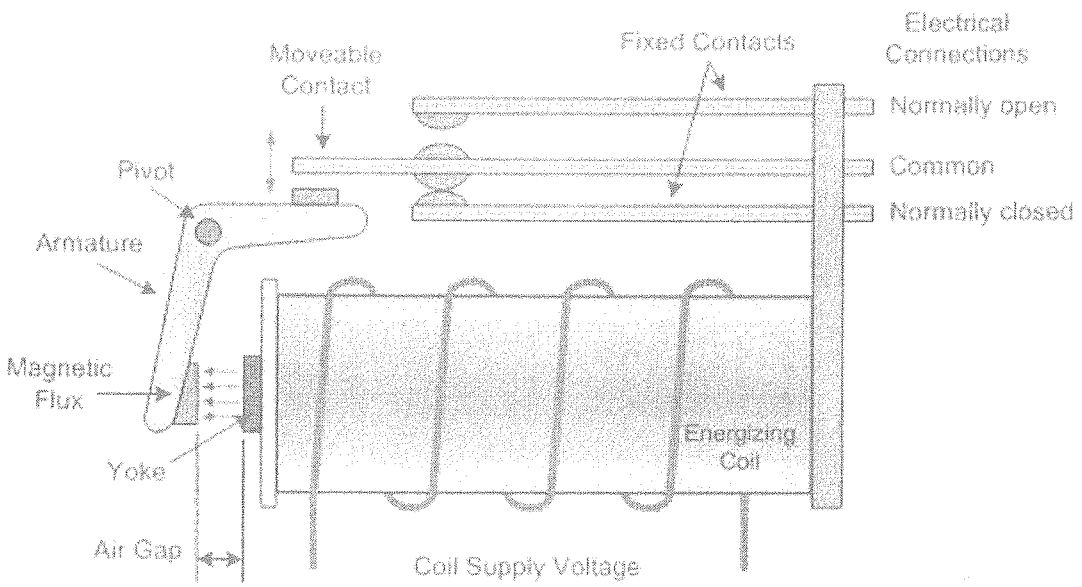

Figure Q5 (a)

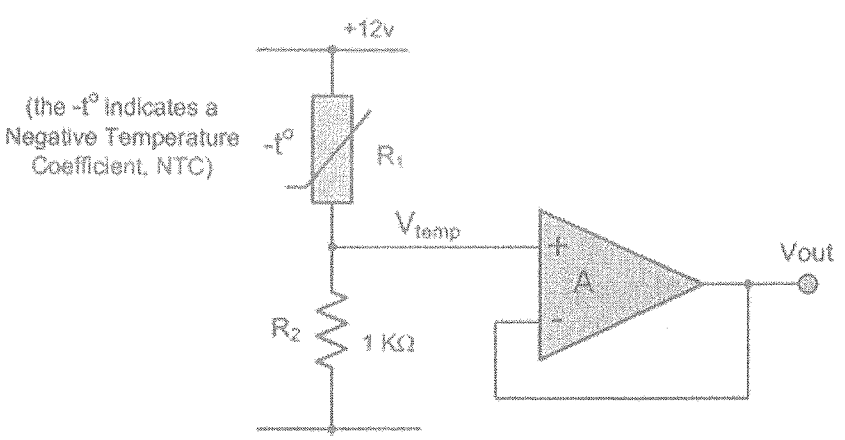

Figure Q5 (b)