

UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: December 2020

Module Number: ME5311 Module Name: Mechatronics and Embedded Systems (N/C)
[Three Hours]

[Answer all questions, each question carries ten marks]

- Q1. a) Explain the following terms related to sensors. Provide one example for each.
- i) Analog to Digital Conversion (ADC)
 - ii) Active vs passive sensing
- [4 Marks]
- b) Assume you are asked to study and prepare a report on traditional fire alarm system and automatic fire alarm system.
- The traditional fire alarm system made of several devices which uses visual and audio signaling to warn people about a possible fire, smoke, or carbon monoxide occurrence in the area of coverage.
- Automatic fire alarm systems are activated through fire detectors, such as smoke, heat, flame or fire gas detectors.
- i) Compare traditional fire alarm system vs. automatic fire alarm system by giving two advantages and disadvantages for both systems.
 - ii) Demonstrate the implementation of the automatic fire alarm system by using a suitable flow chart.
 - iii) State four factors needed to be considered when selecting sensors (smoke and heat) for an automatic fire alarm system.
- [6 Marks]
- Q2 a) Briefly explain the meaning of the electro - mechanical integration process through an example.
- [2 Marks]
- b) Describe two examples for the industrial implementation of embedded sensor systems.
- [3 Marks]
- c) The Automatic door opening systems are used in commercial buildings, shopping malls, theatres, etc. These systems are used to open the door when a person comes near to the entrance of the door and closes it after the person moves away from the door (at entry or exit). There are various kinds of sensors available in the market to make such systems. A leading consumer manufacturer has decided to design a "Smart door system for **domestic use**" and introduce it to the local market.
- i) Identify and explain the key features required for the proposed door system.
 - ii) State two possible sensors that can be used to detect the presence of a person in front of the door and list 4 specifications.

- iii) Demonstrate one possible design for the proposed system using a block diagram.
- iv) State the all hardware components (other than sensors) required to implement the design proposed in above (iii) and list two main specifications for each.

[5 Marks]

Q3 a) In embedded system design “interrupt” has many uses and there are various types of interrupts are available.

- i) What are the two main types of interrupts available with a microcontroller/ microprocessor?

Provide one example for each type and explain its implementation.

- ii) List four advantage of use of interrupts over no interrupts use.

[5 Marks]

b) Windshield control is a vital operation for a driver during driving. The mountings fitted in the windshield (windshields) are essential for smooth driving. These can be automated by using sensors and an embedded microcontroller. A complete windshield controlling system can be developed to increase human comfort and flexibility.

- The wiper is controlled by a water level sensor which regulate the wiper motor through sensing the level of water or rain.
- A dust sensor can be integrated to spill water on the windshield and then wipe it. It senses when a certain level of dust gets accumulated on the windshield.
- A sun visor can be mounted inside the car to shade the driver's eye from sun would be easier to control by a servo motor. It is required to design an automatic sun visor that will be controlled through a light sensor which is used to measure the light intensity and send the signal to the main control unit.

The components of a typical windshield wiper system are shown in Figure Q3.

- i) Based on the description above, state two additional changes you would make to automate the operation. Justify your decision.
- ii) Design a process for the above application including your changes made in (b)(i) above and explain it using a flow chart.

[5 Marks]

Q4 a) Explain the main functions of a DC motor driver.

[1 Mark]

b) Sketch a circuit diagram showing a DC motor connected to a H-bridge motor driver.

[1 Mark]

c) Explain how a DC motor speed can be set to 25%, 50%, 75% and 100% of its maximum speed.

[2 Marks]

d) Write down a C program to implement the speed to 50% (medium) and 75% (high) where 2 pushbuttons are used to START and STOP the motor, and a sliding switch used to set the speed (i.e. medium or high). When the START pushbutton is pressed, the motor drives at the set speed. Assume that you have

an 8-bit microcontroller with enough inputs and output pins and capability to implement this. You also need to drive the motor using an H-Bridge motor driver by referring your answer to above (b).

[4 Marks]

- e) If you are asked to control the motor speed accurately, propose suitable a sensor to measure the speed and explain how you connect it the microcontroller and modify the code in above (d).

[2 Marks]

Q5 a)

Propose sensors for the following measurements (one sensor for each) and explain the working principle of each sensor to obtain the measurements.

- Measuring a horizontal beam bending
- Measuring height of a liquid level in a vertical cylindrical tank

[4 Marks]

b)

Assume that you are a mechatronics engineer of a design firm. One customer wants to automate his manually operated vehicle parking system having a space for 100 vehicles. Customer is expecting to operate the parking system for 24hrs, monitor number of vehicles are parked at present, parking map and the charge for present vehicles. When every vehicle entering to the park, a ticket is issued. The ticket will be printed one of available parking lot and instructed to park the vehicle only that plot. The cost of parking will be calculated by the system based on the parking time as stipulated in the table below. The payment will be collected manually when leaving the vehicle by entering the

No	Total parking time	Charges (Rs.)
1	time \leq 1 hour	100
2	parking time $>$ 1 hour	50 per hour

- Propose suitable hardware components (sensors, controllers, monitoring display and indicators) for the above application.
- Draw a flow chart to implement the operation of the automatic parking describe above. You may make any assumptions and state them clearly.
- Draw a circuit diagram to demonstrate your solution that include 2 vehicles and the hardware components you proposed in b)(i) above.

[6 Marks]

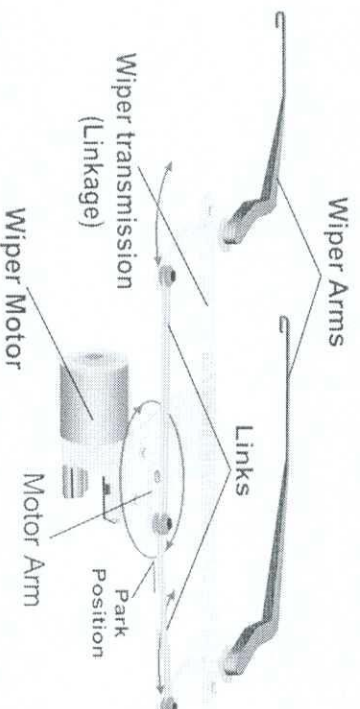


Figure Q3