Heaven's light is our guide

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechatronics Engineering

Lab Report

Course No : MTE 1102
Course Title : Mechatronic System Sessional
Experiment No : 01
Experiment Title : Study of the basic equipment of Mechatronics System.

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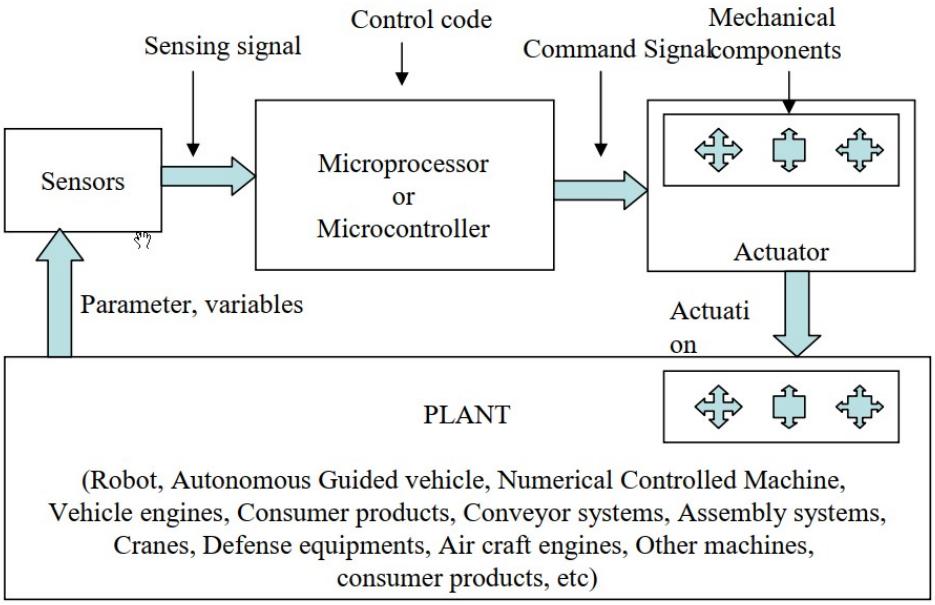
Experiment No.: 01

Name of the Experiment: Study of basic equipment of Mechatronics.

Introduction:

The term mechatronics system encompasses a myriad of devices and systems. Physically, a mechatronic system is composed of four prime components. They are sensors, actuators, controllers, and mechanical components. Input devices such as gas sensor, ultrasonic sensor, temperature sensor, keypad, etc. and output devices such as seven segment display, LCD display, pneumatic actuator, servo motor, stepper motor, DC motor etc. and some controllers such as Arduino, PLC, etc. are the basic components of Mechatronic System.



The figure shows a schematic diagram of a mechatronic system integrated with all the above components.

MTE 1102 course offers hands-on learning with advanced modern types of equipment. Artificial Intelligence and Control System Lab, Robotics and Automation Lab, Computer & Simulation Lab are the three modern and sophisticated laboratories equipped with different instruments and machines to enhance theoretical knowledge with practical experience.

Objectives:

1. To learn about the basic mechatronics systems.
2. To identify the input devices, output devices, and control systems.
3. To visualize the practical working areas and the applications of these basic mechatronics equipment.
4. To know the various pneumatic components used in a pneumatic system and to understand their workings.

Input Devices:

1. Gas Sensor:

Figure 1: MQ-7 Gas Sensor and MQ-135 Gas Sensor.

Specifications:

Parameter name	Technical Condition (MQ-7)	Technical Condition (MQ-135)
Circuit voltage	5V±0.1	5V±0.1
Heating voltage (high)	5V±0.1	5V±0.1
Load resistance	Can adjust	Can adjust
Heating resistance	33Ω±5%	33Ω±5%
Heating consumption	About 350mW	less than 800mw

Table 1: Specifications of MQ-7 and MQ-135 Gas Sensor

Applications:

a. Gas sensors are used in protection of individuals working in hazardous environments where the presence of dangerous gases can be found.
b. Gas sensors are used in monitoring indoor air quality.
c. Aerospace environments utilize gas sensors specifically to monitor for in-flight conditions and air quality maintenance to ensure crew productivity, as well as overall passenger comfort.
d. Gas sensors are also used in agricultural sector to ensure suitable environment in greenhouses for the growth of crops.

2. Ultrasonic Sensor:

Figure 2: HC-SR04 Ultrasonic Distance Sensor.

Specifications:

Parameter name	Technical condition
Working Voltage	DC 5 V
Working Current	15mA
Working Frequency	40Hz
Max Range	4m
Min Range	2cm
Measuring Angle	15 degree
Trigger Input Signal	10uS TTL pulse
Echo Output Signal	Input TTL lever signal and the range in proportion
Dimension	45*20*15mm

Table 2: Specifications of HC-SR04 Ultrasonic Sensor

Applications:

a. Ultrasonic sensors are used for measuring the liquid level in various industries for automated control.
b. Modern vehicles use ultrasonic sensors to measure the distance between the car and the surrounding elements of the road for understanding the environment and drive accordingly.
c. Ultrasonic sensors can be applied to the manufacturing process for automated process control on the factory floor while also being an indispensable tool for companies to maximize efficiency through precise measurement and control.

3. Keypad:

Figure 3: COM-16038 4x4 Matrix Membrane Keypad

Specifications:

Parameter Name	Technical Condition
Maximum Rating	24 VDC, 30 mA
Interface	8-pin access to 4x4 matrix
Operating temperature	32 to 122° F
Dimensions	Keypad: 2.7 x 3.0 in Cable: .78 x 3.5 in

Table 3: Specifications of COM-16038 4x4 Matrix Membrane Keypad

Applications:

a. These type of keyboards are used as input in control systems where human interaction is needed.
b. To implement password protection in any door lock system, this keypad is needed.
c. This keypad could be used in electronic voting machines.

4. Temperature Sensor:

Figure 4: DFR-0198 Digital Temperature Sensor

Specifications:

Parameter Name	Technical Condition
Voltage Range	3.0V to 5.5V
Accuracy	±0.5°C from -10° to +85°C
Usable Temperature Range	-55°C to 125°C
Resolution	9 to 12 bit selectable

Table 4: DFR-0198 Digital Temperature Sensor

Applications:

a. Temperature sensors are mostly used for detection of industrial component's heat measurement for detecting overheating issues.
b. Inside computers, temperature sensors are used to detect overheating of the electronic components and regulate the cooler fan speed accordingly.
c. In 3D printers, temperature sensors are used for measuring the temperature of the melted material for ensuring proper performance and durability of the printed product.

5. DC Power Supply:

Figure 5: Protek PL-3003S power supply

Specifications:

Parameter Name	Technical Condition
Output Power	90W
Output Voltage	0-30V
Output Current	0-3A
Output Port Type	Single Type
Display Type	Back Light 3 Digit LCD

Table 5: Specifications of Protek PL-3003S power supply

Applications:

a. Power supplies are used as precise voltage and current source for a system.
b. For testing and fixing broken systems, where variable power source is needed, these type of power sources are used.

Output Devices:

1. Servo Motor:

Figure 6: SM-S4303 Continuous Rotation Servo Motor

Specifications:

Parameter Name	Technical Condition
Speed	54 rpm at 6V 43 rpm at 4.8V
Stall Torque	71 oz
Lead length	11 inch
Weight	41 g

Table 6: Specifications of SM-S4303 Continuous Rotation Servo Motor

Applications:

a. Servo motors are used in industrial production robots to work accurately in the manufacture process.
b. In digital cameras servo motors are used for auto focusing and self balancing.
c. In elevator technology, servo motors are used for proper accurate height and speed adjustments.
d. In robotics, servos are used for precise actuation.

2. DC Motor:

Figure 7: EG-530AD-2B DC motor

Specifications:

Parameter Name	Technical Condition
Speed	2400 rpm (max)
Current	73mA - 130 mA
Starting Torque	37.2/4.2V
Voltage	6V-12V

Table 7: Specifications of EG-530AD-2B DC motor

Applications:

a. DC motors are used for actuation of robots.
b. In automated vehicles, DC motors are used for various safety features.
c. In industries, DC motors are used as electronic locomotives.
d. In cranes, DC motors are used for hoisting heavy things as these motors have high staring torque capability.

3. 16x2 LCD display:

Figure 8: 16x2 LCD display

Specifications:

Parameter Name	Technical Condition
Input Voltage	3.5V
Supply Current	2.5mA
Enable Pulse width	300ns
Response time	250ms

Table 8: Specifications of a 16x2 LCD display

Applications:

a. This type of LCD display is used for displaying output of different sensors.
b. These are used for creating user interface of a system.
c. These are used extensively in mobile phones, calculators, computers and clocks.

4. Dot LED matrix:

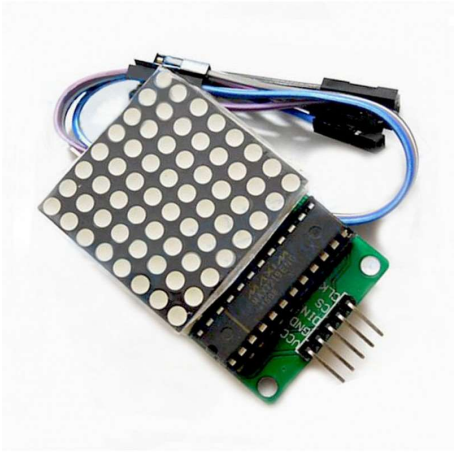


Figure 9: Dot LED Matrix display

Specifications:

Parameter Name	Technical Condition
Input Voltage	5V
Supply Current	320mA
LED colour	Red

Table 9: Dot LED Matrix display

Applications:

a. Dot LED matrix is used in signboards as a cost-efficient way of advertisement.
b. These displays are used in clocks for displaying time.
c. These are used in bus-stops and railway stations as departure indicators.

5. 7-Segment Display:

Figure 10: Dot LED Matrix display

Specifications:

Parameter Name	Technical Condition
Input Voltage	3.3V
Pins	10
Average Power Consumption	86mW

Table 10: 7-Segment display

Applications:

a. These type of displays are used in showing numerical data output from any device or sensor.

b. Calculators, digital clocks, radios, electronics meters use them extensively.

6. Oscilloscope:

Figure 11: Protek-5100 Digital Oscilloscope.

Specifications:

Parameter Name	Technical Condition
Bandwidth	100MHz
Channels	2 channels + 1 Extension
Range	2.5ns/Div-50s/Div
Step	1-2.5-5 order

Table 11: Protek-5100 Digital Oscilloscope.

Applications:

a. Oscilloscopes are used to show electrical signals and how those signals change over time.

b. Primarily these are used for measuring voltage waves..

c. This device is used for testing and debugging electric circuits.

7. Pneumatic Actuator:

Figure 12: Pneumatic Actuator.

Specifications:

Parameter Name	Technical Condition
Fluid	Air
Pressure	0.2-0.7mPa
Actuation type	Double acting
Bore Size	88mm

Table 12: Specifications of pneumatic actuator

Applications:

a. Used in various industries where it converts energy of compressed air into a mechanical motion.
b. These are used in aeroplane doors, wings, automatic doors, industrial processes.
c. These are also used in mechanical robots.

Controllers:

1. Arduino:

Figure 13: Arduino Uno R3

Specifications:

Parameter name	Technical Condition
Micro-controller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz

Table 13: Specifications of Arduino Uno R3

Applications:

The applications of Arduino Uno mainly involves in Arduino Uno based projects which include the following

a. Visitor Alarm in Office using Arduino Uno
b. Arduino Uno based Soccer Robot
c. Arduino Uno based Automatic Medication Reminder
d. Motion Detecting with Static Electricity
e. Arduino Uno based Taxi with Digital Fare Meter
f. Arduino Uno based Smart Stick
g. Robot Car Controlled by Smartphone and Arduino

2. PLC:

Figure 14: SIMATIC S7-1200

Specifications:

Parameter Name	Technical Condition
Power Dissipation	14W
Digital Input Current	4mA input used
Bit Memory	8192 bytes
Pulse Catch Input	14
Onboard Digital I/O	14 inputs / 10 outputs
Onboard Analog I/O	2 Inputs / 2 Outputs

Table 14: Specifications of SIMATIC S7-1200

Applications:

- Industrial Applications:
  1. Time and Count-based Control System for an Industrial Machine.
  2. Temperature Controller or Humidity by using the Sensors Input to the PLC system.
  3. Fault Detection and Protection of Industrial Machines like an Induction Motor.
- Power Station Applications:
  1. PLC uses for the Smart Grid System to Monitor and Detect fault conditions.
  2. It is used in the Power Generation, Transmission, and PLC Distribution System.
- Domestic Applications:
  1. Water Tank Level Control System.
  2. Car Washing and Parking System.
  3. Flashing Light Controlling System.
  4. Automatic Door Opening/Closing System.

3. Sweep Function Generator:

Figure 14: Protek 9205C 0.02 Hz ~ 2 MHz Sweep Function Generator

Specifications**:**

Description		Specification
Output	Frequency Range	0.02Hz to 2MHz (7Ranges)
	Accuracy	Over 1Hz ± Count ± Time Base Error
	Amplitude	1Vp to 20Vp (Open Circuit), 0.5Vp to 5Vp(50 Ω)
	Attenuation	Fixed 20dB ±1dB, 20dB Continuity Variable
	Impedance	50Ω ±5%
Sine wave	Flatness	Better Than ±3dB ~ 2MHz at Max. Output
	Distortion	2% (10Hz ~100kH2)
Square Wave	Rise / Fall Time	100ns or Less
Triangle Wave	Non-linearity	1% to 100kHz
	Symmetry Variation	1:1 ~ 4:1
	VCF Input	OV ~ 10V DC
Sweep function	Mode	Linear
	Width	10:1 ~ 100:1
	Time	0.5Hz(2sec) to 50Hz (20msec)
Frequency counter	Range	10Hz ~ 2MHz
	Accuracy	0.01% ±1Count
	Max. Input Voltage	70Vp
	Input Impedance	1MΩ

Table 14: Specifications of Protek 9205C 0.02 Hz ~ 2 MHz Sweep Function Generator

Application:

a. Used for testing DC power supply
b. For testing the delay margin
c. Analyze the audio DAC
d. To test clock frequency functional range of digital circuits
e. Employed for testing and optimization of engine controlling units
f. Analyze switching signals of IGBT circuitry

Applications:

1. Industrial Robotic Arm:

Figure-15: FANUC LR-Mate 200ID

Specifications:

Parameter Name	Technical Condition
Controlled Axes	6
Max Payload	7kg
Repeatability	0.01mm
Mounting Method	Floor/Upside Down/Angle
Reach	717

Table-15:Specifications of FANUC LR-Mate 200ID

Applications:

a. FANUC robots are used in factories around the globe to help manufacturers improve quality, increase capacity and overcome skills shortages.
b. This type of robots build products too intricate for human hands to assemble, prepare pharmaceuticals in aseptic conditions and protect workers from dangerous or harmful environments.
c. FANUC Robotics produces industrial robots that can be used in wielding automation and robotic assembly applications.

2. Industrial Control Work Cell:

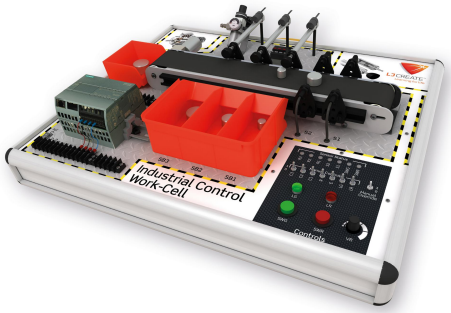


Figure-16: Industrial Control Work Cell.

Specifications:

Parameter Name	Technical Condition
Trainer Dimensions	660 x 600 x 160 mm (W x D x H)
Power Requirements	110- 240V, 50-60 Hz
Packed Volume	Approx. 0.378 m^3
Packed Weight	Approx. 25.68 Kg

Table-16: Specifications of industrial Control Work Cell

Applications:

1. Industrial Control Work Cell have been designed to provide practical real world problem solving tasks and activities within the classroom or lab environment.
2. The Industrial Control Trainer offers a classroom based resource for practical investigation of automated control systems.
3. Students will have access to hands on learning opportunities within our optional cloud-based STEM curriculum software packages.
4. This trainer includes access to digital curriculum materials including theory and practical learning tasks, as well as tutor support resources.

Precautions:

1. When observing the lab equipments, extra care and caution were taken.
2. All high voltage parts and connections were kept out of the way from accidental touching.
3. Whether the connections with the load were causing sparks was carefully checked.
4. Rubber floor mates were used to insulate ourselves from the ground when working in the lab.
5. After finishing the observation, all connections to the power supply was removed.

Discussion & Conclusion:

We are able to successfully obtain our objectives of the observation on the basic mechatronics equipment. Like, we have come to learn about some input devices such as gas sensor,ultrasonic sensor,temperature sensor,keypad etc. & output devices such as seven segment display, LCD display, pneumatic actuator, servo motor, Stepper motor, DC motor etc. and some controllers such as arduino, PLC etc.We study on internet and books to find out the specification,application of these device and collect the image of these equipment.So,we also manage to learn about the applications of these basic components in various mechatronics devices and systems.In some case we are able to know how can we drive the device and how the devices run.
However, as a fresher on this site,we have faced so many difficulties.Like we are confused about some devices, whether they are input device or output device or just a controller.We have our hand short of information to make the datasheets of some devices.Despite having all of these problems,we have successfully managed to complete our objectives.
Gaining Knowledge about the basic mechatronics systems and their applications will help us in the future to do bigger and more complicated experiences confidently and correctly.

As a new comer we must know about the basic mechatronic equipments first.And in this experiment we all are able to know the specification,application of some input device,output device,some actuators,controllers and some sensors.