# HMI MECHTRONICS INTERNSHIP

*An Internship Report Submitted at the end of eighth semester*

**BACHELOR OF TECHNOLOGY**

**IN**

**MECHANICAL ENGINEERING**


*Submitted By*

**GORLE ADITHYA**

**(21981A0344)**


*Under the esteemed guidance of*

HMI Engineering Services

&

**Dr. AMIT KUMAR MEHAR**
(Associate professor)


**DEPARTMENT OF MECHANICAL ENGINEERING**

**RAGHU ENGINEERING COLLEGE**

**(AUTONOMOUS)**

**Affiliated to JNTU GURAJADA,VIZIANAGARAM**

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## DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

## CERTIFICATE

This is to certify that this project entitled **"MECHTRONICS"** done by **"GORLE ADITHYA (21981A0344)**" is a student of BTech in the Department of Mechanical Engineering Raghu Engineering College, during the period 2021-2025, in partial fulfilment for the award of the Degree of Bachelor of Technology in Mechanical Engineering to the Jawaharlal Nehru Technological University, Gurajada Vizianagaram is a record of bonafide work carried out under my guidance and supervision.

The results embodied in this internship report have not been submitted to any other University or Institute for the award of any Degree.

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# DISSERTATION APPROVAL SHEET

*This is to certify that the dissertation*

***MECHTRONICS(HMI) INTERNSHIP BY***

**GORLE ADITHYA (21981A0344)**

*Is approved for the degree of* ***Bachelor of Technology***

**PROJECT GUIDE** **Designation**

**Internal Examiner**

**External Examiner**

**HOD**

Date:

## DECLARATION

This is to certify that this internship titled **"HMI MECHTRONICS"** is bonafied work done by my me, impartial fulfillment of the requirements for the award of the degree B.Tech and submitted to the **Department of Mechanical Engieering,**

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I also declare that this internship is a result of my own effort and that has not been copied from anyone and I have taken only citations from the sources which are mentioned in the references.

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**Date:**

**Place:**

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Industrial Internship Certification

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Scoring Grade: "A+"

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Regards

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# ABSTRACT

A large share of automotive innovations consists of significant improvements in formerly pure mechanical systems which are made possible using integrated electronics together with complex information processing. Such mechatronic systems require a concurrent design of mechanical, electronical, and information processing subsystems in order to reach the cost requirements of the automotive industry. The motivation for the use of mechatronics is discussed, as well as the most important technological challenges of the mechatronic approach.

Mechanical engineering, one of the most prominent branches of engineering, experienced rapid growth in the early 19th century, serving as the backbone of industrial development and revolution. However, with advancements in technology and increasing demands for higher efficiency and automation, traditional mechanical systems alone struggled to keep pace. To bridge this gap, mechanical engineering integrated principles from electronics and computing, giving rise to mechatronics—a revolutionary and interdisciplinary field.

Mechatronics is the seamless integration of mechanical, electrical, and computer engineering, enabling the development of intelligent and automated systems. Today, it plays a crucial role in various industries, including automotive systems, robotics, fluid control systems, and many more, driving innovation and efficiency in modern technology.

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# INTRODUCTION

## 1.1 Introduction of the Organistaion.

Centre for Research and Industrial Staff Performance (CRISP), Bhopal, was established in 1997 as a society under the Indo-German Technical Cooperation agreement. The Ministry of MSME, Government of India, served as the line ministry for this project, while the Department of Technical Education & Skill Development, Government of Madhya Pradesh, and the German Technical Cooperation agency (GTZ) were the implementation partners. Headquartered in Bhopal, CRISP operates both nationally and internationally, focusing on human resource development and organizational development. Its activities cater to government bodies, industries, academic institutions, developmental organizations, and civil society.

The organization boasts excellent infrastructure, including sophisticated laboratories in the fields of Industrial Automation, Mechatronics, Production Technology, Information & Communication Technology (ICT), and Multimedia Technology. CRISP is recognized as one of the most preferred service providers in Technical Vocational Education & Training (TVET), Training Institution Management, and Entrepreneurship Development.

**FEATURES OF THE ORGANIZATION**

**FEATURES OF THE ORGANISATION**

A. A nodal Centre for Department of Technical Education & Skill Development Government of Madhya Pradesh for technical and management staff capacity building.

B. More than 500 delighted clients from Industries, Central & State Government Organizations, Academia, Developmental Organizations etc.

C. A role model for German Technical Co-operation Agency (GTZ) for replicating CRISP like successful Project in India and other countries.

D. Practicing professional & management principles in our operations.

E. Facilitating applications of e-Governance for State Govt. of Madhya Pradesh.

F. A strong team of qualified & experienced employees (more than 150) capable of handling technical and educational projects within India & overseas.

## AREA OF SPECIALIZATIONS

1. **Manufacturing Technology** – CNC Technology, CAD/CAM (Unigraphics, Pro-E, CATIA, SolidWorks, & I-DEAS), AutoCAD.
2. **Industrial Automation** – PLC, Variable Frequency Drives, Field Instrumentation, MMI, Hydraulics, Pneumatics.
3. **Mechatronics** – Mechanical, Electrical, Electronics, Instrumentation, IT.
4. **Car Mechatronics**
5. **Behavioural Sciences and Management** – Leadership Development, Communication Skills, Team Building, etc.
6. **Information Technology** – Application & Software Development, Hardware & Networking Training, Web Designing, etc.
7. **Vocational Education & Training** – Design & development of curriculum & study materials, Train the Trainers, Instructors Training, Trade Identification Survey, Impact Study, etc.
8. **Fashion, Interior & Graphic Designing**
9. **Multimedia** – 3D Animation, Non-Linear Video Editing, Show Reel Development.
10. Entrepreneurship Development

# OBJECTIVES

1 Define Mechatronics

2 Locate and identity Electronics Controls in fuel System

3 Locate and identify Electronics Controls in Air System

4 Locate and identify Electronics Controls in Ignition System

5 Locate and identify Electronics Control in Exhaust System

6 Differentiate between Fuel Injection System and Non Fuel Injection System (Carburetebased)

7 State drawbacks of Non Fuel Injection System

8 List benefits of Fuel Injection System

9 Define Mechanical Systems

10 Describe controls in Fuel System

11 Describe controls in Air System

12 Describe controls in Ignition System

13 Describe controls in Exhaust System

14 Describe controls in Suspension System

15 Describe controls in Steering System

16 Describe controls in Brake System

17 Describe controls in Safety System

18 Define Electricity in terms of voltage, current and resistance

19 Calculate Ohm's Law Measure Electricity

20 Conduct test using a Multimeters

21 Analyse Series and Parallel Circuit

22 Describe Open and Short Circuit

23 Performing Circuit Test

24 Performing Component Test

25 Describe material properties Conductivity and Non conductivity

26 Describe auto electrical circuits and their symbols

27 Define Sensors, Actuators & ECM

28 Describe various types of sensors & Actuators

29 Explain working principle of various types of sensors & Actuator

30 Explain characteristics of various types of sensors & Actuators

31 Draw and explain sensor flow diagrams

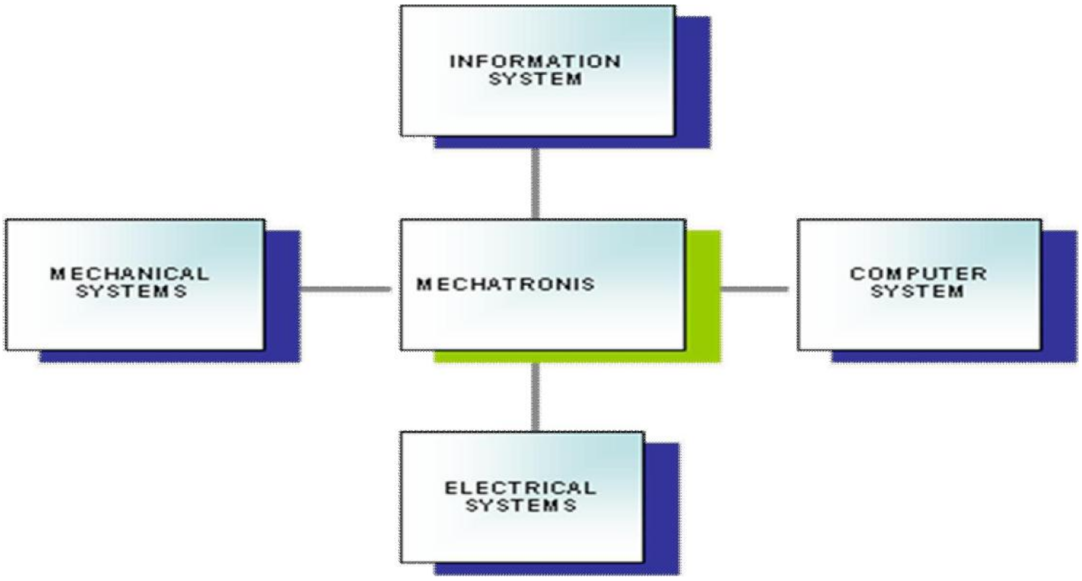
32 Describe input/output of sensors & actuators

33 Make visual inspection of Sensors, Actuators and Wiring Harness

34 Conduct test on Sensors & various modules of ECM

35 Describe input/output parameters of ECM

36 Explain modules of ECM




# Applications of Mechatronics

**Mechatronics Applications**

- **Smart Consumer Products** – Home security systems, cameras, microwave ovens, toasters, dishwashers, laundry washer-dryers, climate control units, etc

- **Medical** – Implant devices, assisted surgery, haptics, etc.

- **Defense** – Unmanned air, ground, and underwater vehicles, smart munitions, jet engines, etc.

- **Manufacturing** – Robotics, automated machines, and industrial processes.

- **Automotive** – Climate control, antilock braking systems, active suspension, cruise control, airbags, engine management, safety features, etc.

- **Network-Centric and Distributed Systems** – Distributed robotics, telerobotics, intelligent highways, etc.

- **Methodology**

  A methodology is a collection of practices, procedures, and rules followed by professionals in a particular branch of knowledge or discipline. Familiar technological disciplines that contribute to mechatronics include mechanical engineering, electrical engineering, computer science, and information technology.

# CHAPTER 3

Disciplinary Foundations of Mechatronics

- Mechanical Engineering
- Electrical Engineering
- Computer Engineering
- Computer/Information Systems

## Multi-/Cross-/Inter-Disciplinary

**Products and processes requiring inputs from more than one discipline can be realized through the following types of interactions:**

- **Multi-disciplinary** – This is an additive process of bringing multiple disciplines together to address a problem.
- **Cross-disciplinary** – In this approach, one discipline is examined from the perspective of another discipline.
- **Inter-disciplinary** – This is an integrative process involving two or more disciplines simultaneously to solve a problem.

## Sequential/Concurrent Product Realization

At best, these processes are **multi-disciplinary**, calling upon discipline specialists to "design by discipline." The steps involved include:

- **Designing the mechanical system ("plant").**
- **Selecting sensors and actuators** and mounting them on the plant.
- **Designing signal conditioning and power electronics.**
- **Designing and implementing control algorithms** using electrical, electronics, microprocessor, microcontroller, or microcomputer-based hardware.

## Mechatronics-based Product Realization

### Role of Systems Engineering in Mechatronics

Systems engineering enables the **design, analysis, and synthesis** of products and processes involving components from multiple disciplines.

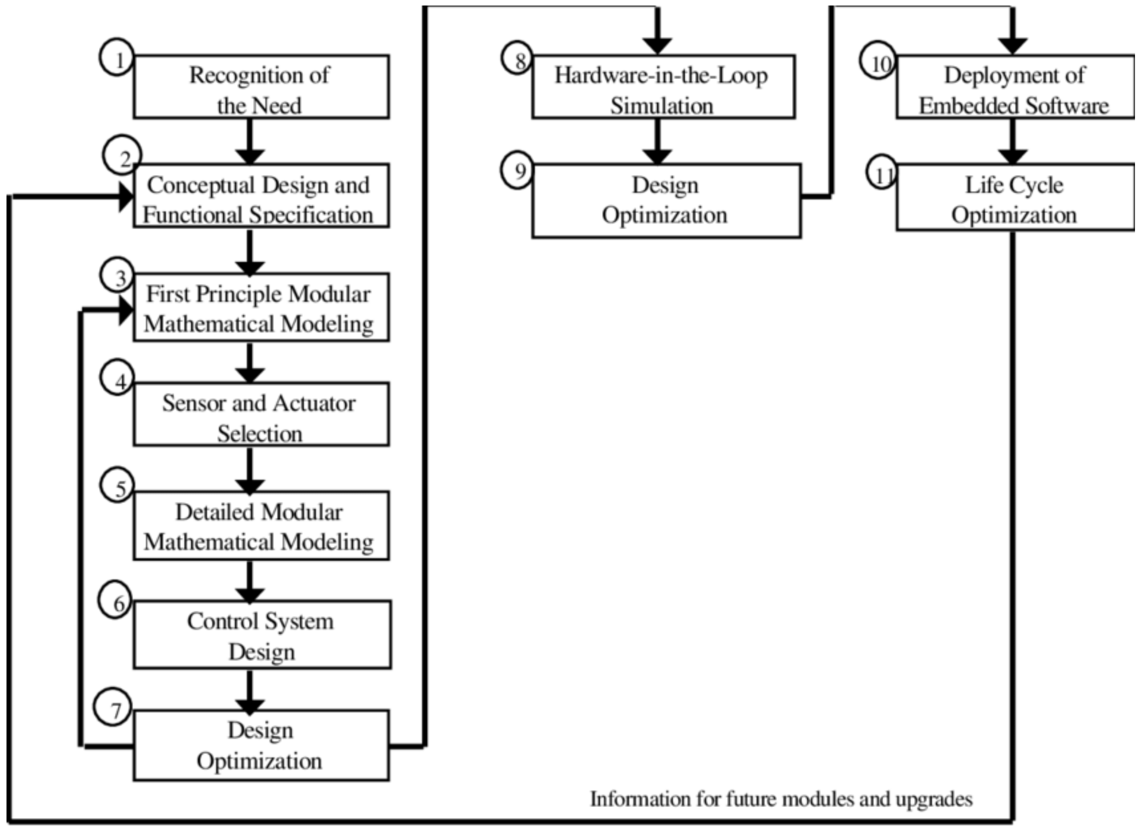
- **Mechatronics** leverages systems engineering to guide the product realization process through various stages, including **design, modeling, simulation, analysis, refinement, prototyping, validation, and deployment**.
- In **mechatronics-based product realization**, mechanical, electrical, and computer engineering, along with information systems, are **integrated throughout the design process**, ensuring that the final product is greater than the sum of its parts.

### What a Mechatronics System Is Not:

A mechatronics system is **not**:

- Simply a **multi-disciplinary** system.
- Simply an **electromechanical** system.
- Just a **control system**.

## Mechatronic Design Process




## Evolution of Mechatronics as a Contemporary Design Paradigm

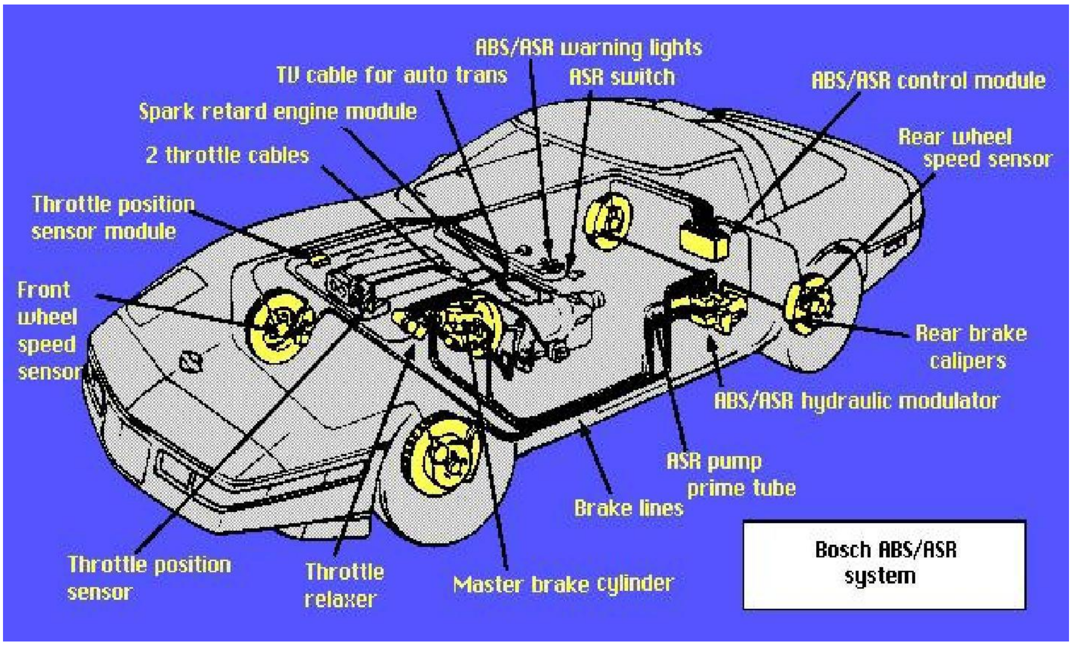
## MECHANICAL SYSTEMS

### *ANTILOCK BRAKES SYSTEM (ABS)*

Antilock brakes are an **enhanced version of ordinary braking systems**. Simply put, the **antilock braking system (ABS)** is designed to prevent the brakes from locking up and skidding during hard braking or when braking on **wet or slick surfaces**.

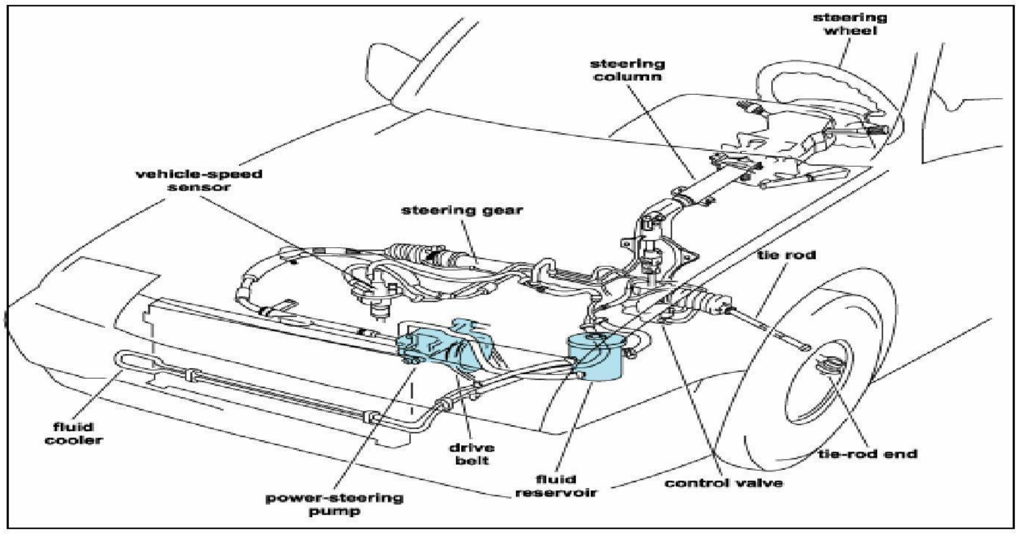
This system significantly enhances **safety** in everyday driving by:

- Preventing dangerous skids.
- Allowing the driver to **maintain steering control** while trying to stop.



# AUTOMOTIVE STEERING

The means by which a motor vehicle is controlled about the vertical axis




## Industrial Revolution

Allowed design of products and processes for energy conversion and transmission thus

allowing the use of energy to do useful work.

• **Engineering designs of this era were largely mechanical**

e.g., operations of motion transmission, sensing, actuation, and computation were

performed using mechanical components such as cams, gears, levers, and linkages)

**Purely mechanical systems suffer from**

- Power amplification inability.
- Energy losses due to tolerances, inertia, and friction.

## Elements of Mechatronics—Mechanical

- Mechanical elements refer to – mechanical structure, mechanism, thermo-fluid, and hydraulic aspects of a mechatronics system.
- Mechanical elements may include static/dynamic characteristics.
- A mechanical element interacts with its environment purposefully.
- Mechanical elements require physical power to produce motion, force, heat, etc

## Elements of Mechatronics—Electromechanical

**Electromechanical elements refer to:**

– Sensors

• A variety of physical variables can be measured using sensors, e.g., light using photo-resistor, level and

displacement using potentiometer, direction/tilt using magnetic sensor, sound using microphone, stress and

pressure using strain gauge, touch using micro-switch, temperature using thermistor, and humidity using

conductivity sensor

– Actuators

• DC servomotor, stepper motor, relay, solenoid, speaker, light emitting diode (LED), shape memory alloy,

electromagnet, and pump apply commanded action on the physical process • IC-based sensors and actuators

(digital-compass, -potentiometer, etc.).

IC-based sensors and actuators (digital-compass, -potentiometer, etc.).

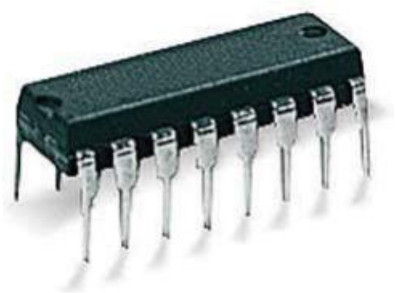

## Elements of Mechatronics— Electrical

• Electrical elements refer to:

Electrical components (e.g., resistor (R), capacitor (C), inductor (L),transformer, etc.), circuits, and analog signals

• Electronic elements refer to: analog/digital electronics, transistors, thyristors, opto-isolators, operationalamplifiers, power electronics, and signal conditioning.

• The electrical/electronic elements are used to interface electromechanical sensors and actuators to the control interface



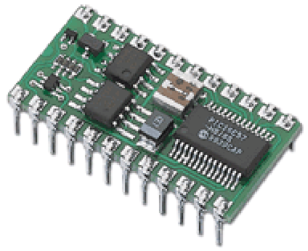
## Elements of Mechatronics—Control Interface/Computing Hardware

Control interface/computing hardware elements refer to:

– Analog-to-digital (A2D) converter, digital-to-analog (D2A) converter, digital input/output (I/O), counters, timers, microprocessor, microcontroller, data acquisition and control (DAC) board, and digital signal processing (DSP) board

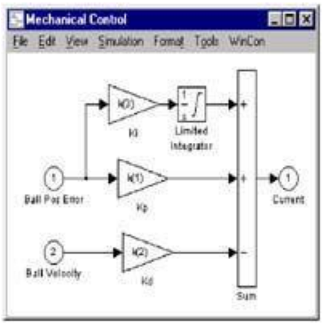
• Control interface hardware allows analog/digital interfacing: communication of sensor signal to the control computer and communication of control signal from the control computer to the actuator

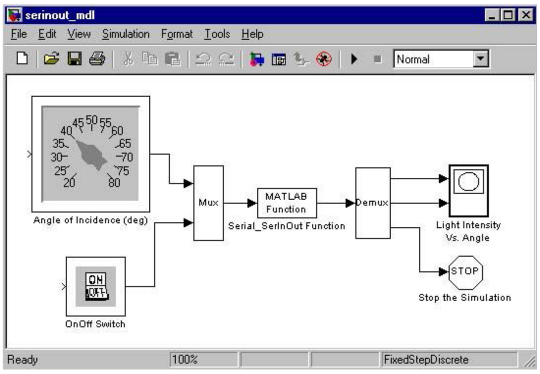
• Control computing hardware implements a control algorithm, which uses sensor measurements, to compute control actions to be applied by the actuator.

## Elements of Mechatronics— Computer/Information System

• Computer elements refer to hardware/software utilized to perform:
– computer-aided dynamic system analysis, optimization, design, and simulation
– virtual instrumentation
– rapid control prototyping
– hardware-in-the-loop simulation
– PC-based data acquisition and control




## Elements of Mechatronics

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Typical knowledgebase for optimal design and operation of mechatronic systems comprises of:

– Dynamic system modeling and analysis

• Thermo-fluid, structural, hydraulic, electrical, chemical, biological, etc.

– Decision and control theory

– Sensors and signal conditioning

– Actuators and power electronics

– Data acquisition

• A2D, D2A, digital I/O, counters, timers, etc.

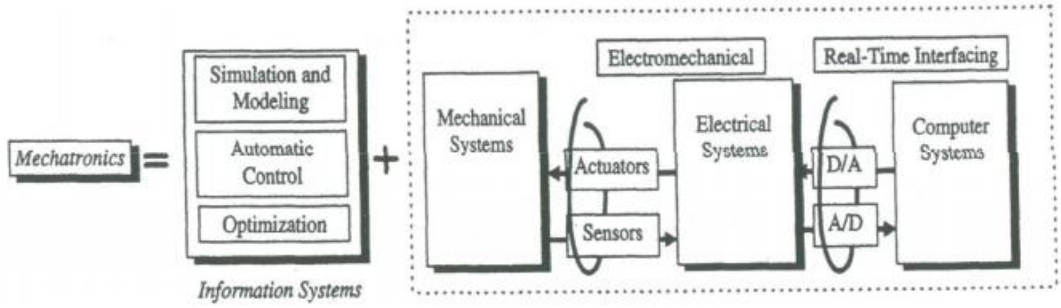
– Hardware interfacing

– Rapid control prototyping

– Embedded computing

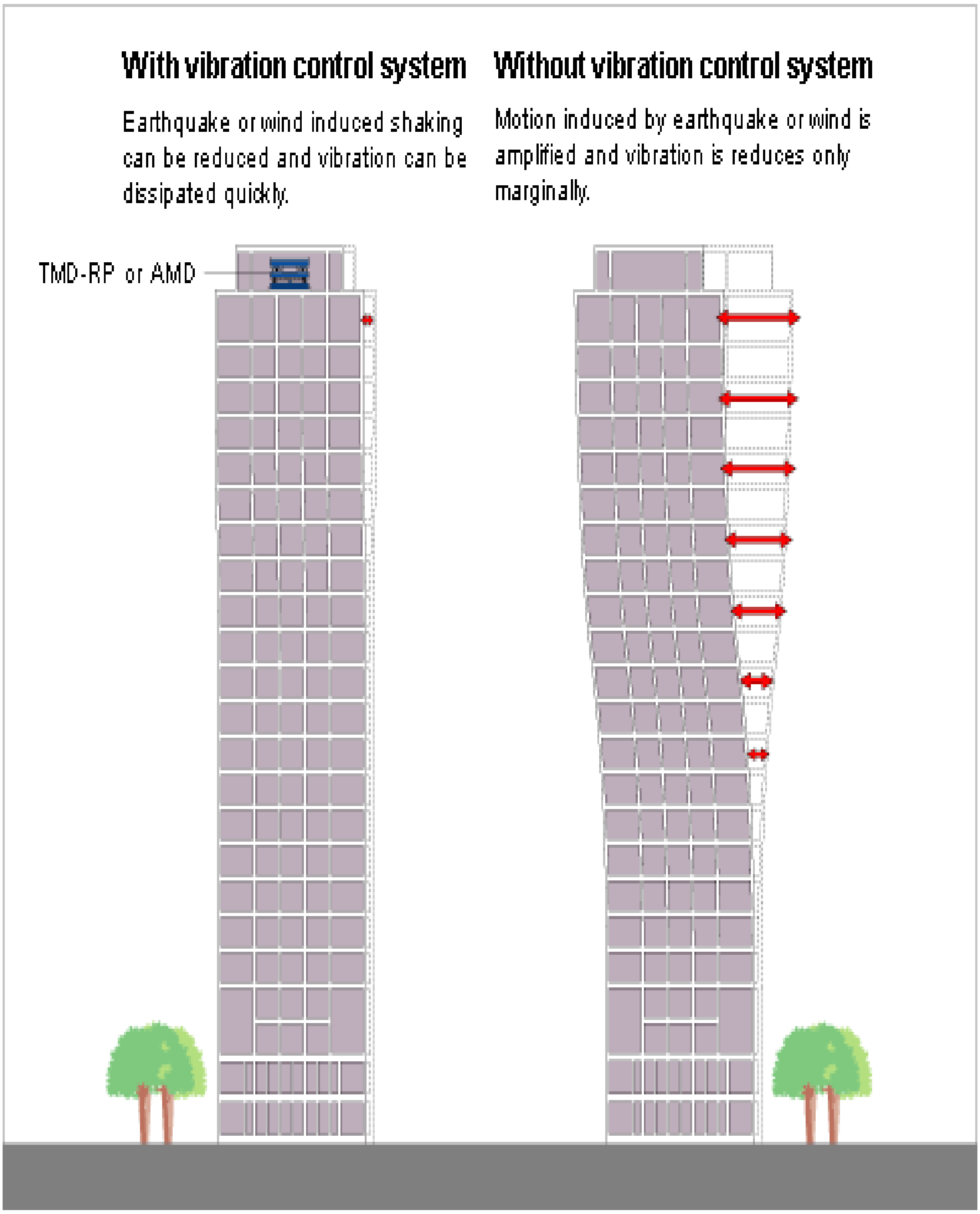
Balance theory, simulation, hardware, and software

**Key Elements of Mechatronics Structural Control**



# CHAPTER 4

## Structural Control



# INTERNET OF THINGS

The Internet of Things (IoT) refers to the inter-networking of physical devices embedded with electronics, software, sensors, actuators, and network connectivity, enabling these objects to collect and exchange data.

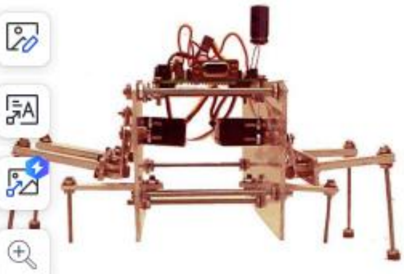
IoT and mechatronics are complementary fields. Many smart components associated with IoT are fundamentally mechatronic in nature. The rapid development of IoT is compelling mechatronics engineers, designers, and educators to explore new approaches in:

Perception, design, and manufacturing of mechatronic systems and components.

- Addressing emerging challenges such as data security, machine ethics, and human-machine interaction.

**Home Automation**

## Robotics

## Future Trends in Mechatronic Engineering

### Human Learning and Mechatronics

One of the remarkable abilities of human beings is learning from past experiences to improve future performance. This learning ability enables humans to act autonomously and communicate to accomplish collective tasks. These fundamental abilities are shaping the trends in mechatronics.

In mechatronic systems, certain tasks have already been enabled through different technological disciplines:

Actuation (Task v) – Enabled by Mechanical Engineering (M).

Signal Communication (Task ii) – Enabled by Electrical Engineering (E).

Signal Processing & Decision Making (Task iv) – Enabled by Computer (C).

### Advancements in Sensor Technologies

Many modern mechatronic systems already possess rudimentary sensing abilities. Examples include:

- Air conditioning units that sense temperature and humidity, using fuzzy logic reasoning.
- CNC machining systems that monitor cutting forces, tool fractures, machining noise, vibrations, and motor current.

Mechatronic devices will **form networks** or "societies" with a **common purpose**. This concept aligns with **Marvin Minsky's "The Society of Mind"**, which describes intelligence as an **emergent property of interconnected smaller processes**.

# Conclusion

The future of mechatronics will be shaped by rapid advancements in:

Artificial Intelligence & Machine Learning

- Sensor Fusion & Data Processing
- Autonomous Systems & Modular Design
- Miniaturization & IoT Connectivity

To keep pace with these changes, future mechatronics engineers must continuously update their skills and knowledge to design and integrate the next generation of intelligent systems.