

POSTAL **Book Package**

2023

Mechanical Engineering

Conventional Practice Sets

Robotics and Mechatronics

Contents

Sl. Topic	Page No.
1. Microprocessor and Microcontroller	2 - 8
2. Sensor and Other Device	9 - 19
3. Actuators and Stepper Motor	20 - 27
4. Control System	28 - 40
5. Robotics	41 - 59



MADE EASY
Publications

Note: This book contains copyright subject matter to MADE EASY Publications, New Delhi. No part of this book may be reproduced, stored in a retrieval system or transmitted in any form or by any means. Violators are liable to be legally prosecuted.

Microprocessor and Microcontroller

Q1 Explain with the help of a block diagram the elements of mechatronic design?

Solution:

A block diagram of general mechanical design elements is shown in figure

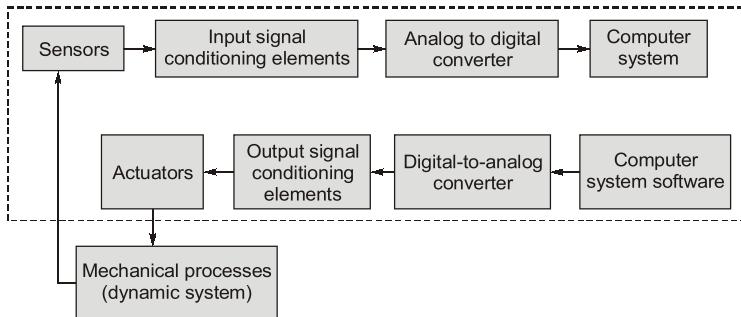


Fig. Block diagram of general mechanical

- The sensory system comprises sensor or transducers. The output of this system is applied to signal conditioning elements (also called signal processors). The function of signal conditioning elements to take care of the output of a transducer, an analog signal (voltage or current) that is continuous and time varying (i.e. not in desired form). Most common operational amplifiers (op-amps) with passive elements can be used as signal conditioning elements. Other signal conditioning elements are ladder, subtracter, integrator differentiator, converters, comparator, sample and hold amplifier etc.
When the system is microprocessor or microcontroller or computer based then analog-to-digital converters are used as signal conditioning elements.
- In mechatronic systems the actuators are employed, which are parts of the physical process being monitored and controlled. Actuation is the result of a direct physical action on process directly. This motion or action can be applied to mechanical process or structure through actuators.
“Actuators” take low-power signals from computers through signal conditioning elements and produce high output signals that are applied to the process as input. Stepper motor, solenoids, synchros are some of the examples of actuators.

Other control architectures:

For obtaining completeness in the integration of mechanical devices, sensors, and signal and power electronics in the most advanced mechatronic system, it is essential to include microprocessor-based control systems.

- Analog circuits:** Several mechatronic designs need a specific actuator output based on an analog input signals. In order to effect the desired control, in some cases, analog signal processing circuits consisting of operational amplifiers and transistors can be used.
 - ‘Analog controller’s are often simple to design and easy to implement and can be less expensive than microprocessor-based systems.
- Digital circuits:**
 - When the input signals are digital or can be converted to a finite set of states, then combinational or sequential logic controllers may be easy to implement in mechatronic design.
 - In case of the simplest designs, a few digital chips are employed to create a digital controller. For generating complex Boolean functions on a single IC (integrated chip), specialised digital devices

such as PAL (programmable array logic) controllers and PLAs (programmable logic arrays) can be used to reduce the complexity of design. Sometimes, it may be economically feasible to design an ASIC (application-specific integrated circuit) that provides unique digital functionality on a single IC. An ASIC solution, in high-volume manufacturing applications, can be cheaper, smaller and requires less power.

3. Programmable logic controller (PLC):

A PLC is a sequential logic device that generates output signals according to logic operations performed on the output signals. A typical PLC consists of the following ports:

- Integrated power supply; – Central processing unit;
- Memory elements; – Programmer/monitor;
- Input and output modules.
- PLCs are specialised industrial devices for interfacing to and controlling analog and digital devices.
- They are usually provided with “ladder logic” which is a graphical method of laying out the connectivity and logic between system inputs and outputs.
- Besides being flexible and easy to program, they are robust and relatively immune to external interference.

4. Microcontroller:

- The microcontroller (a microcomputer on a single IC) provides a small, flexible control platform that can be easily embedded in a mechatronic system.
- It can be programmed to perform a wide range of control tasks.

5. Single-board computer:

- A single-board computer is considered to be a good alternative when an application requires more features or resources than can be found on a typical microcontroller, and size is not a major concern.
- These computers are easily interfaced to a personal computer; this is useful in the testing and debugging stages of design development and for downloading software into the memory of the single-board computer.

6. Personal computer:

- A desktop or laptop personal computer (PC) may serve as an appropriate control platform in large sophisticated mechatronic systems.
- The personal computer can be easily interfaced to sensors and actuators, using commercially available plug-in-data acquisition cards.
- PC-controlled mechatronic systems are especially common in research and development testing and product development laboratories.

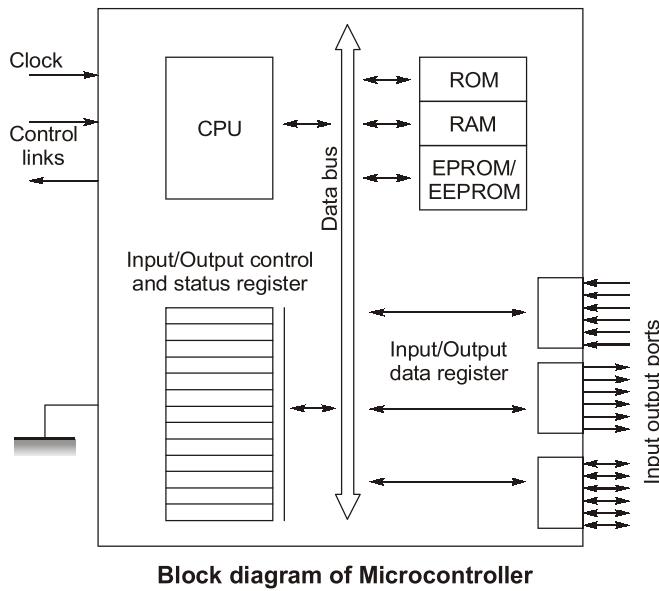
Q.2 Given comparison between “Microprocessors” and “Microcontrollers”.

Solution:

Microprocessor	Microcontroller
<ol style="list-style-type: none">1. It contains CPU, interrupt circuit and memory-addressing circuits.2. Access time for memory and I/O device is more.3. Number of operational codes (for moving data from external memory to CPU) are many.4. Nature of deal with rapid movement of codes and data are from external address to chip.5. Operates as a digital computer by adding external digital parts.6. Memory map for data and code are single.7. More flexible.	<ol style="list-style-type: none">1. Besides all parts of micro-processor, they also contain, timers, parallel and serial I/O, internal RAM and ROM.2. Access time for memory and I/O device is less.3. Only one or two operational codes (for moving data from external memory to CPU)4. Nature of deal with rapid movement of codes and data are within the chip.5. Operational as a digital computer without adding external digital parts.6. Memory map for data and code are separate.7. Less flexible.

Q3 Sketch the block diagram of a microcontroller?

Solution:

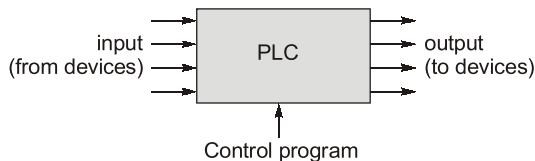


Block diagram of Microcontroller

Q4 What are programmable logic controllers (PLC). State the special features and advantages of PLCs.

Solution:

PLCs are specialized industrial device for interfacing input/output and controlling analog and digital devices.



- (i) They are designed with a small instruction set suitable for industrial control application.
- (ii) Usually they are programmed with "ladder logic" which is graphical method of laying out the connectivity and logic between system input and output.
- (iii) They are designed with industrial control and industrial environments specifically in focus. Therefore in addition to being flexible and easy to program, they are robust and relatively immune to external interference.
- (iv) It is a 'digital electronic device' that uses a programmable memory to store instruction and to implement functions. Such as logic sequencing, timing, counting and arithmetic in order to control machines and process.

Special features of PLCs

- (i) Interfacing for input and output is inside the controller.
- (ii) Easily understood programmable language program is mainly concerned with logic and switching operation.
- (iii) Rugged and designed to withstand vibration, temperature, humidity and noise.

Advantage:

- (i) Low cost.
- (ii) Easy to install.
- (iii) Ensure increased productivity.
- (iv) Faster operational speed.
- (v) High reliability and ease maintenance.