# CNC MACHINES AND AUTOMATION

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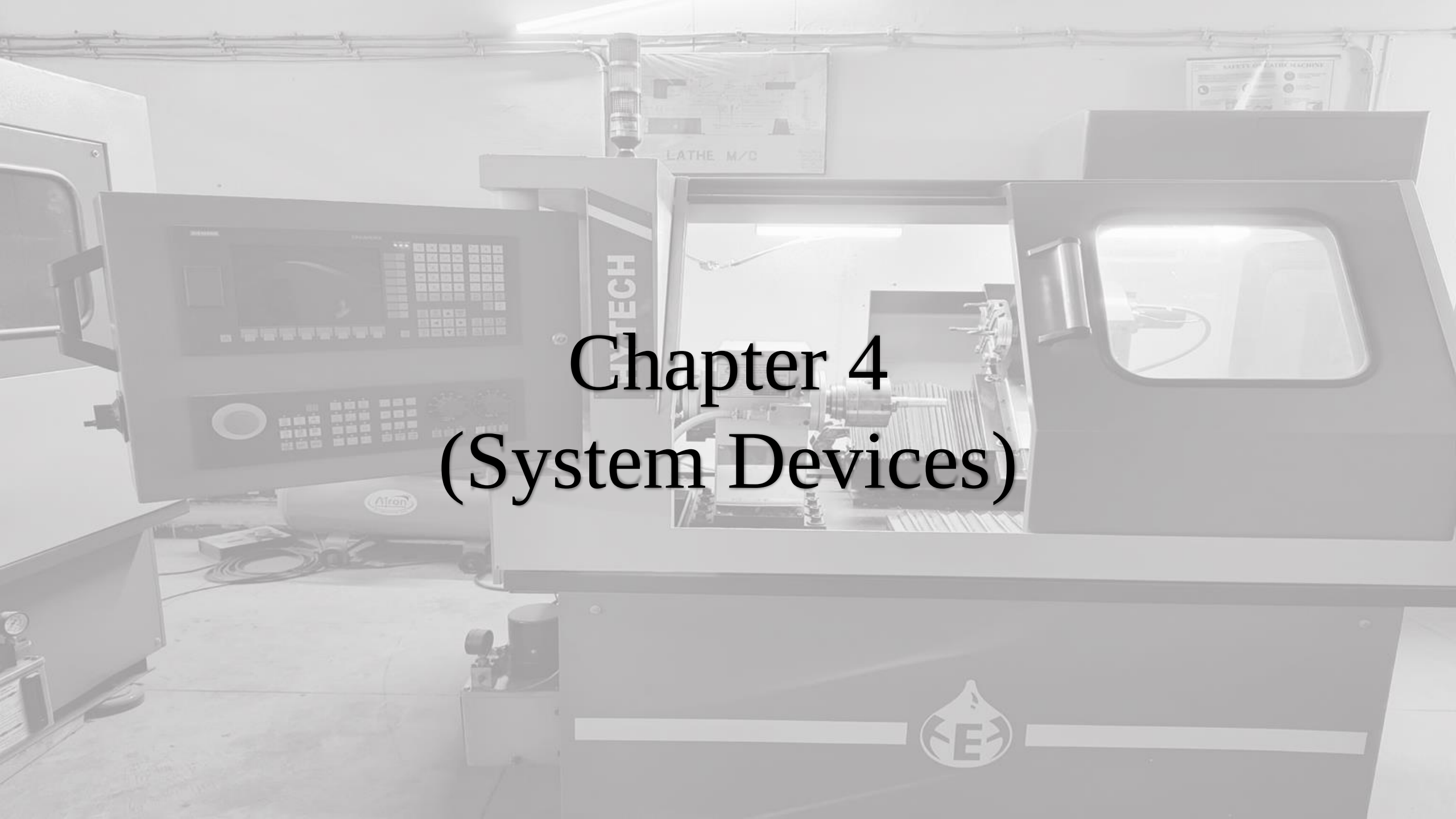
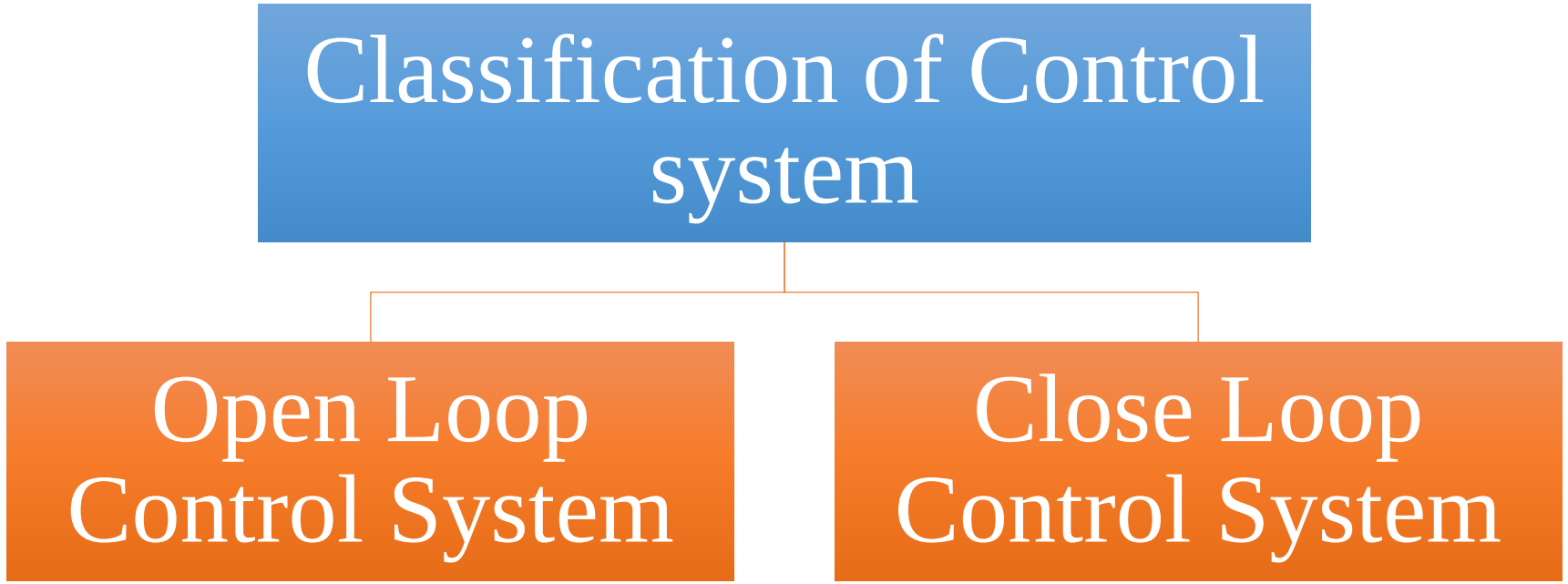



# Chapter 4
# (System Devices)

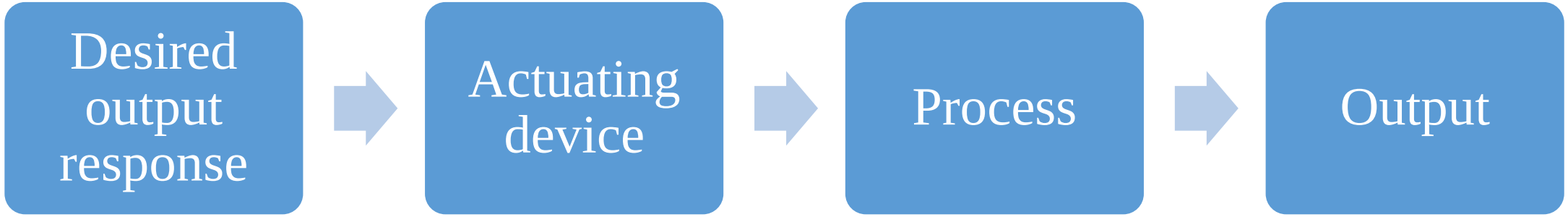
# Control system

Control system mean by which a variable quantity or set of variable quantities is made to conform to a prescribed norm. It either holds the values of the controlled quantities constant or causes them to vary in prescribed way. A control system may be operated by mechanical means, by electricity, by fluid pressure or by a combination of means etc.

# Control system



**Open loop control system**: - It is also known as non-feedback control systems. When in a physical system there is no automatic correction of the variation present in its output then, it is called an open loop control system.




**Open-loop control system**

Example: Automatic washing machine, Traffic signal system, Electric toaster, home heating system

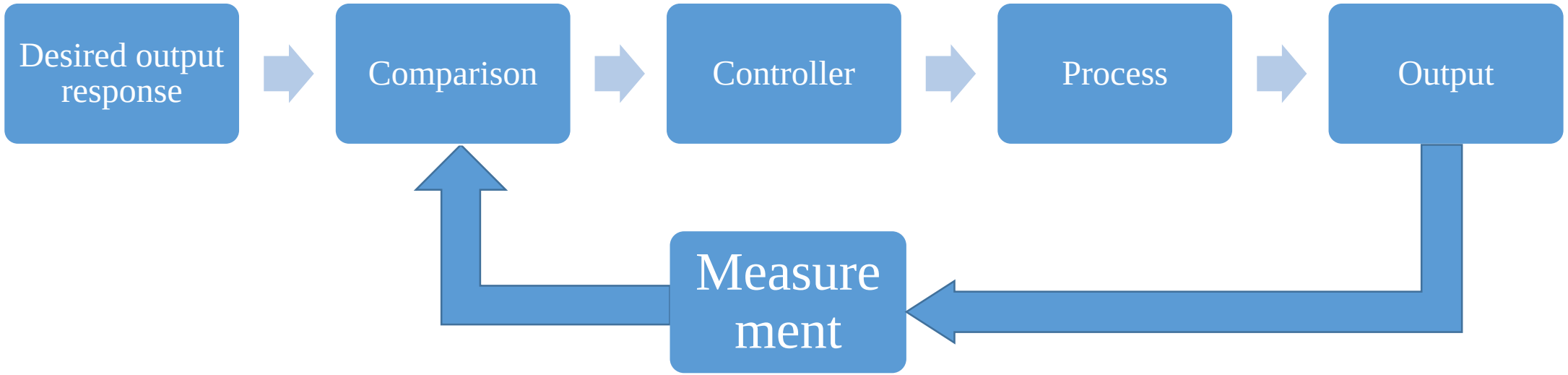
Advantage

1. These are less costly
2. These are simple
3. These are easier to maintain and are popular with smaller NC machines.

Disadvantage

1. The major drawback of the open loop system is that there is no way to correct any error that might occur during operation because there is no feedback to the controller.

**Close loop control system**: - It is also known as feedback control systems. It is system where the output has an effect upon the input quantity in such a manner as to maintain the desired output value.




**Close-loop control system**

Example: Speed control system, Pressure control system, Temperature control system, Robot control system

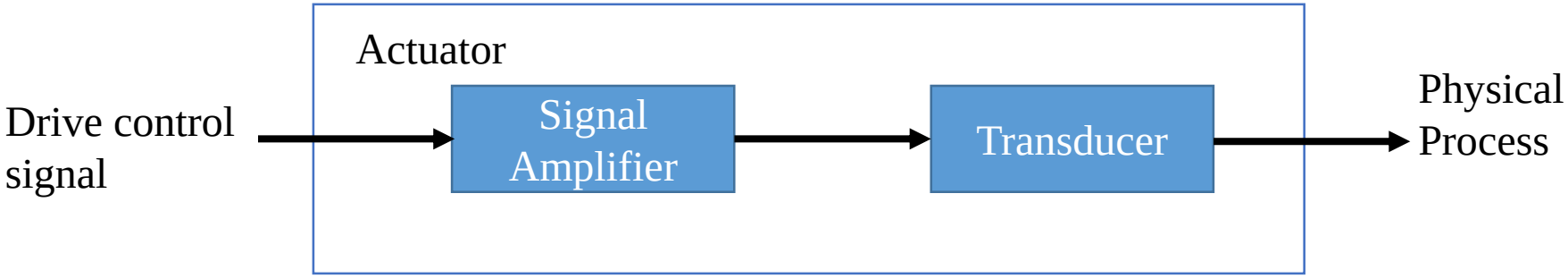
**Advantage**

1. High accuracy can be achieved.
2. There is an automatic comparison for error
3. It is more preferred in large NC machines

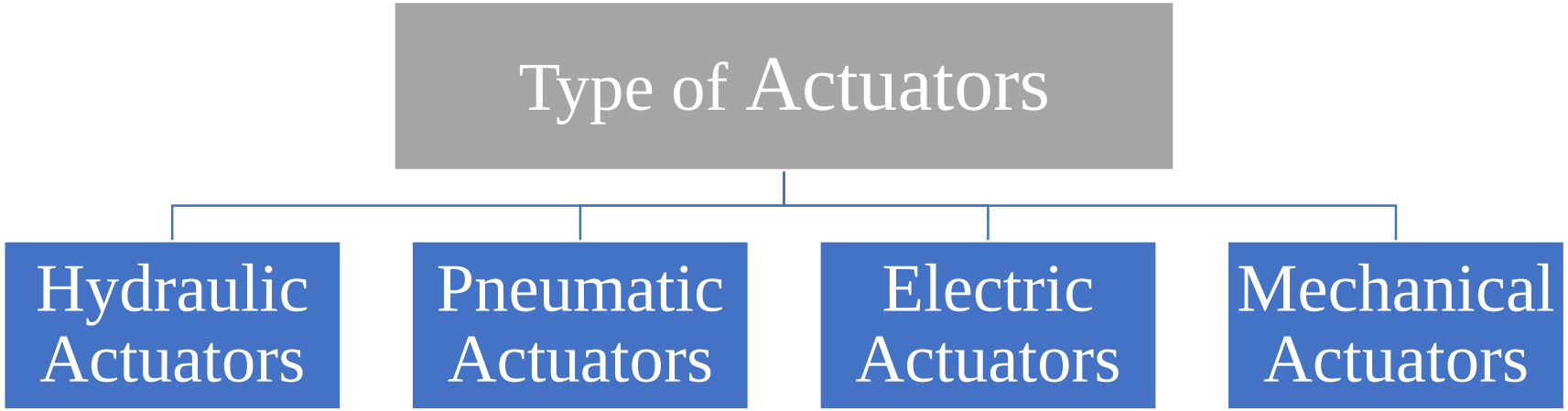
**Disadvantage**

1. These system are more complex.
2. It is more expensive to buy and maintain.

**Actuators**: - An actuator is a kind of motor that controls or moves mechanism or systems. It is operated by a source of energy, typically electric current, hydraulic fluid pressure, pneumatic pressure.
Internally, an actuators can be broken into two separate module: the signal amplifier and the transducers.




**Structure of an Actuator**



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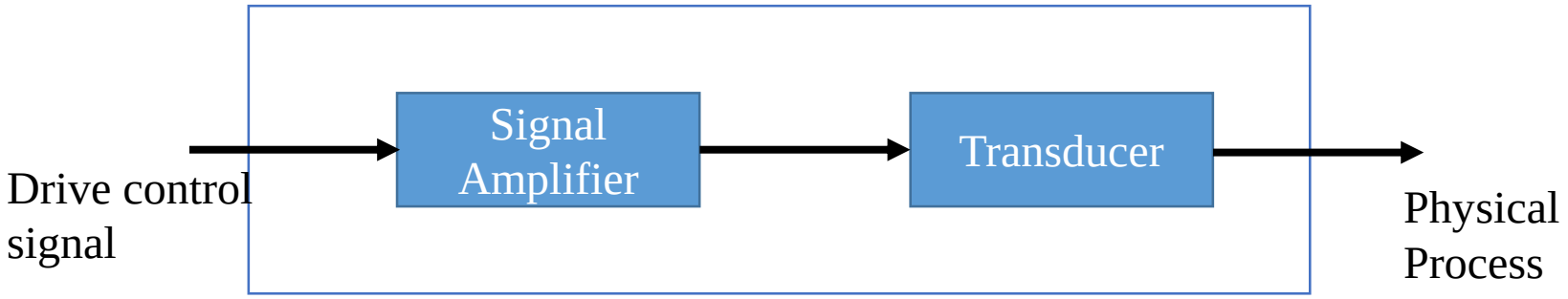
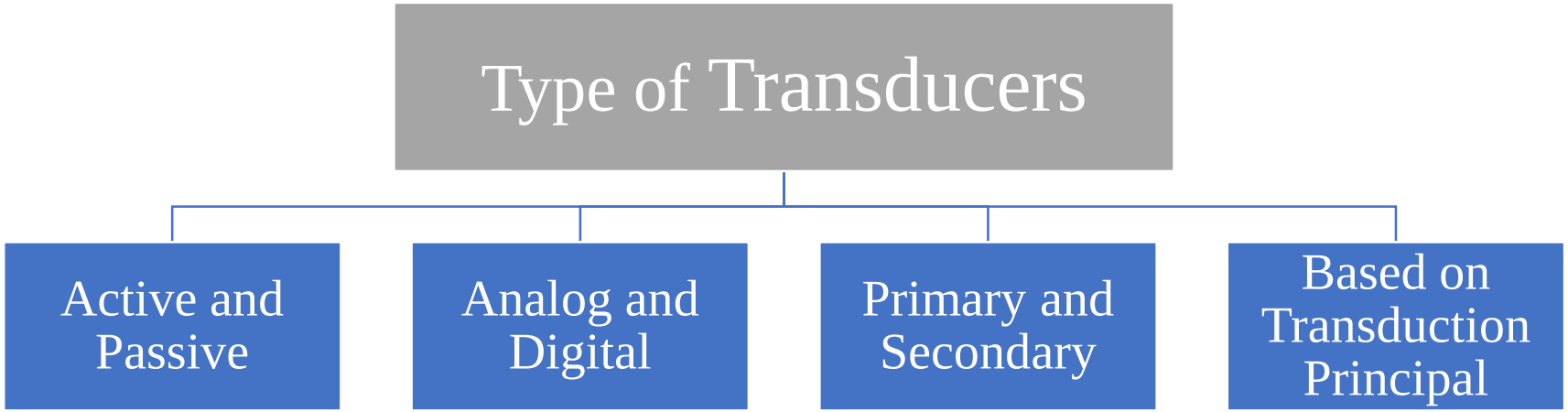



Actuator

**Structure of  an Actuator**

**Transducer**: - A transducer can be defined as a device capable of converting energy from one form into another. It converts the physical quantity into a proportional electrical quantity such as voltage or current.


**Transducer Block Diagram**



# Characteristics of a Transducer

i) Ruggedness: - Ability to withstand overloads, with safety stops for overload protection

ii) Linearity: - Ability to reproduce input-output characteristics symmetrically and linearly

iii) Repeatability: - It is the ability to reproduce the output signal exactly when the same measurand is applied repeatedly.

iv) High stability and Reliability: - Minimum errors in measurement, no effect of temperature and environmental variations.

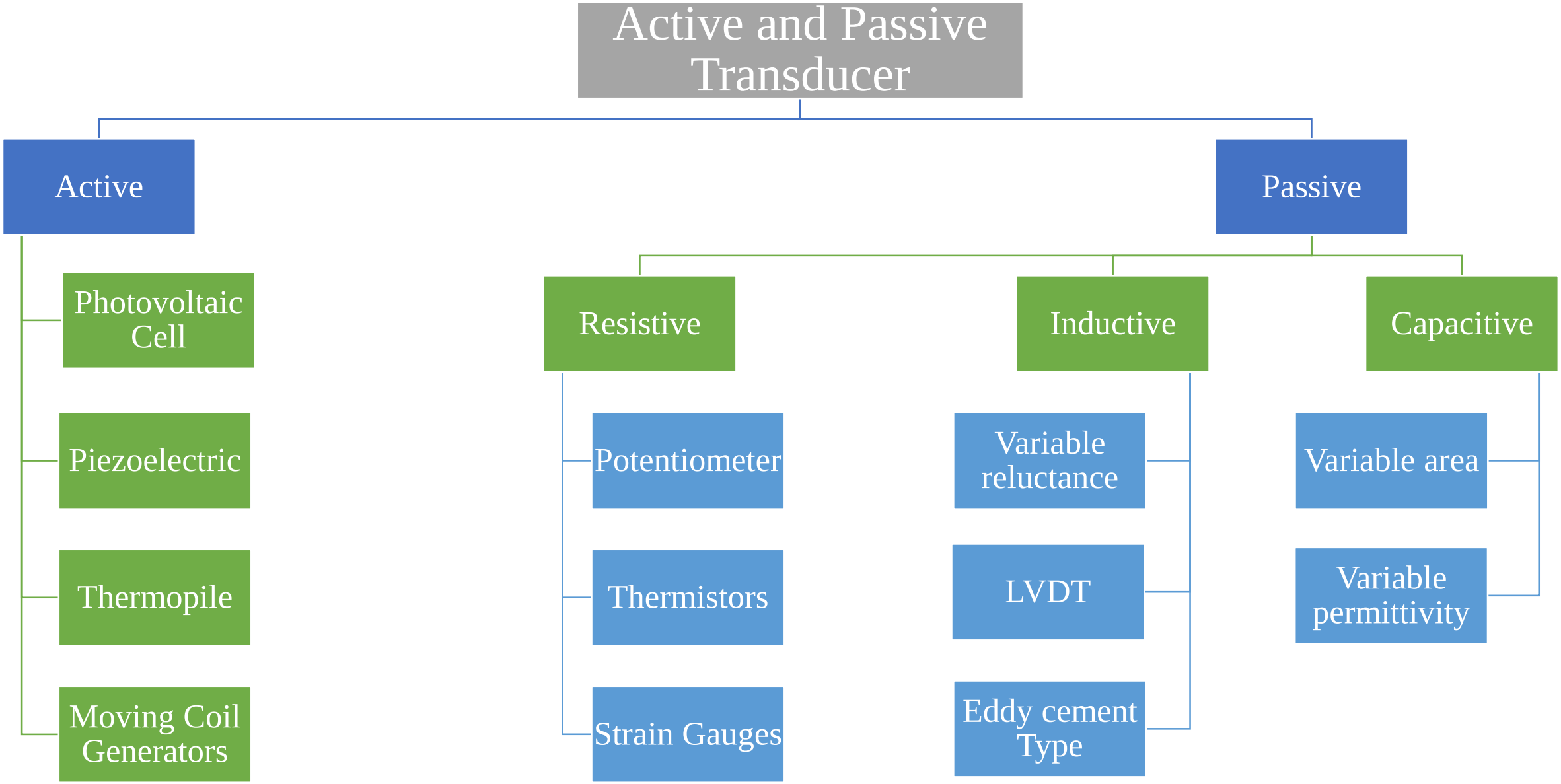
v) Speed Response: - Output is faithful to input when taken as function of time. This effect is analyzed as the frequency response.

vi) Convenient Instrumentation: - Adequately high analog output signal with high signal to noise ratio

vii) Excelled mechanical characteristics

viii) Built in integrated device with noise, asymmetry, and other defects minimized.

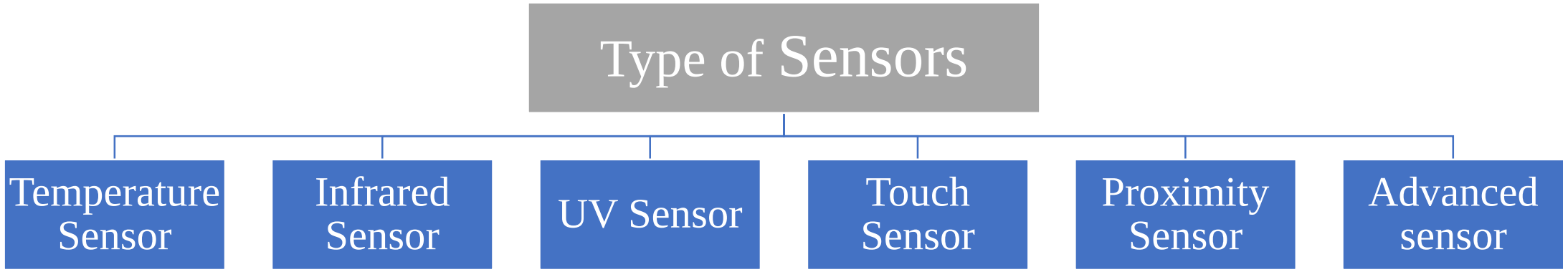
ix) Smaller in size and weight


Active and Passive Transducer
Active
Photovoltaic Cell
Piezoelectric
Thermopile
Moving Coil Generators
Passive
Resistive
Potentiometer
Thermistors
Strain Gauges
Inductive
Variable reluctance
LVDT
Eddy cement Type
Capacitive
Variable area
Variable permittivity

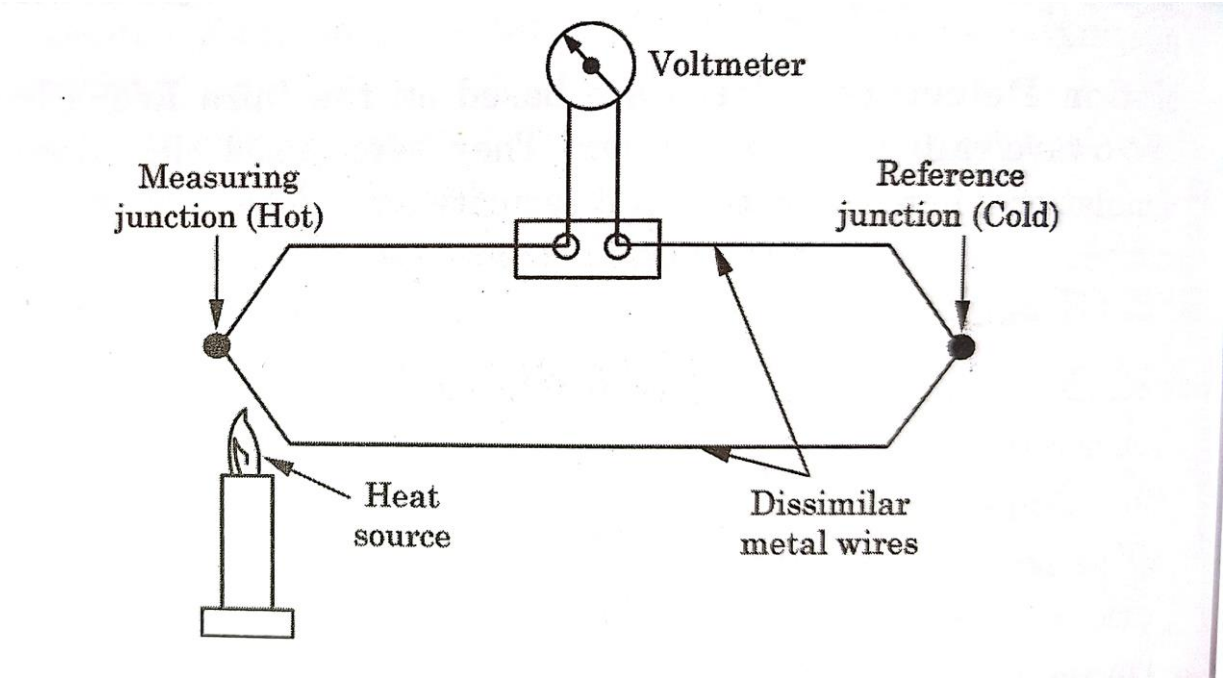
**Sensors**: - Sensors are sophisticated devices that are frequently used to detect and respond to electrical or optical signals. They produce a signal for purposes of detecting a property such as force, position, temperature, pressure, humidity, speed, vibration etc.

## Criteria to select a Sensor

- Accuracy
- Range – measurement limit of sensor
- Environmental condition – usually has limits for temperature/humidity
- Cost
- Calibration-Essential for most of the measuring devices as the reading change with time.
- Resolution – Smallest increment detected by the sensor.
- Repeatability – The reading that varies is repeatedly measured under the same environment.



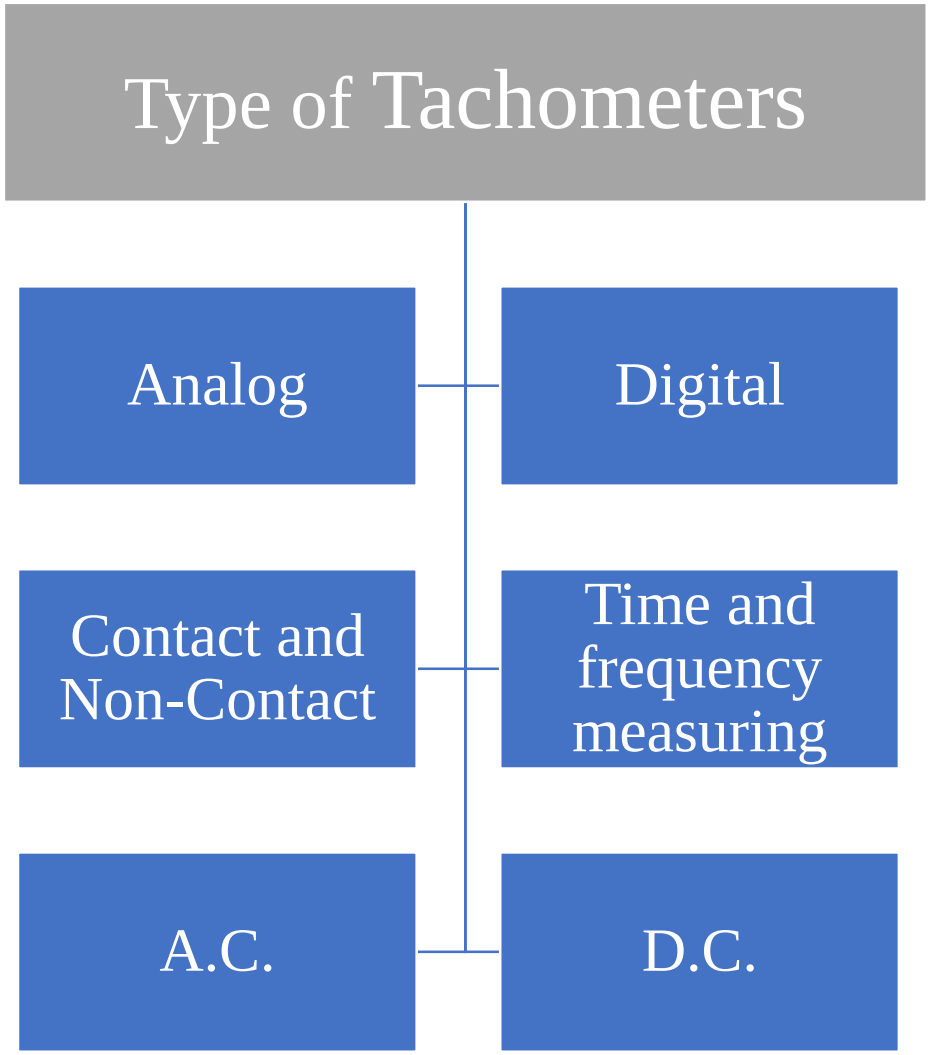
**Temperature Sensor**: It collects information about temperature from a source and converts into a form that is understandable by other device or person.



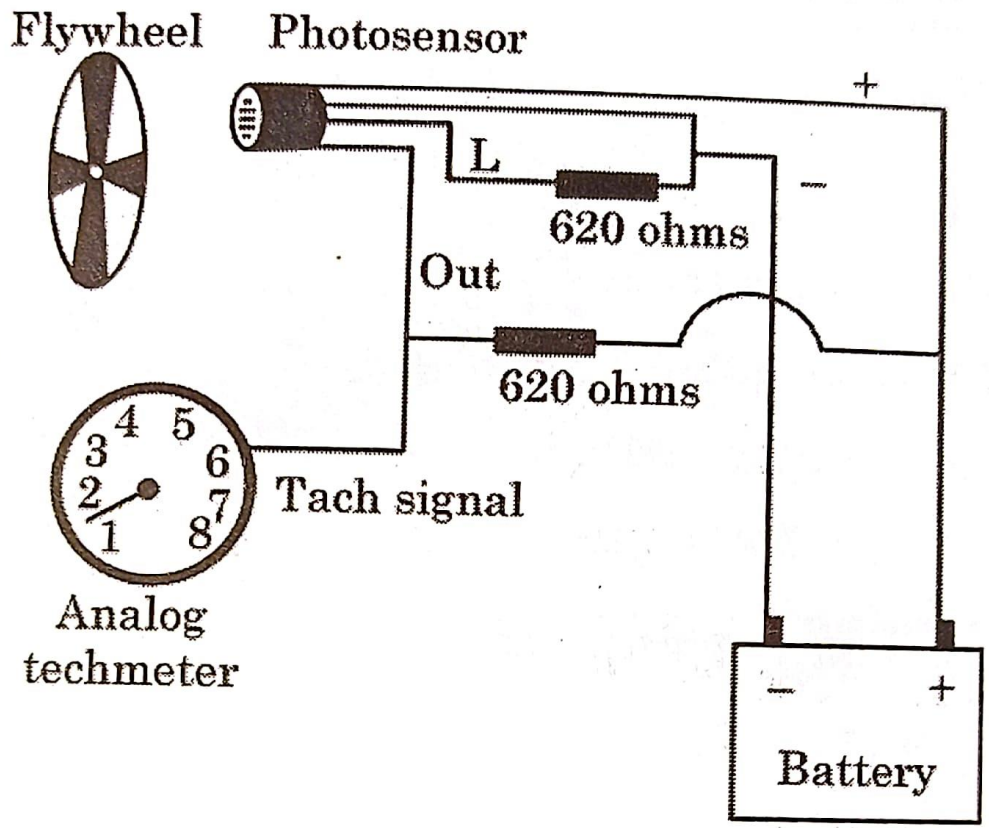

Thermocouple

Refer to book for other sensors and for more details

**Tachometer**: - It is an instrument designed to measure the rotation speed of an object, such as a gauge in an automobile that measures the revolution per minute of engine's crankshaft.



**Analog Tachometer**: It comprises a needle and dial-type of interface. They don't have provision for storage of readings and cannot compute details such as average and deviation.

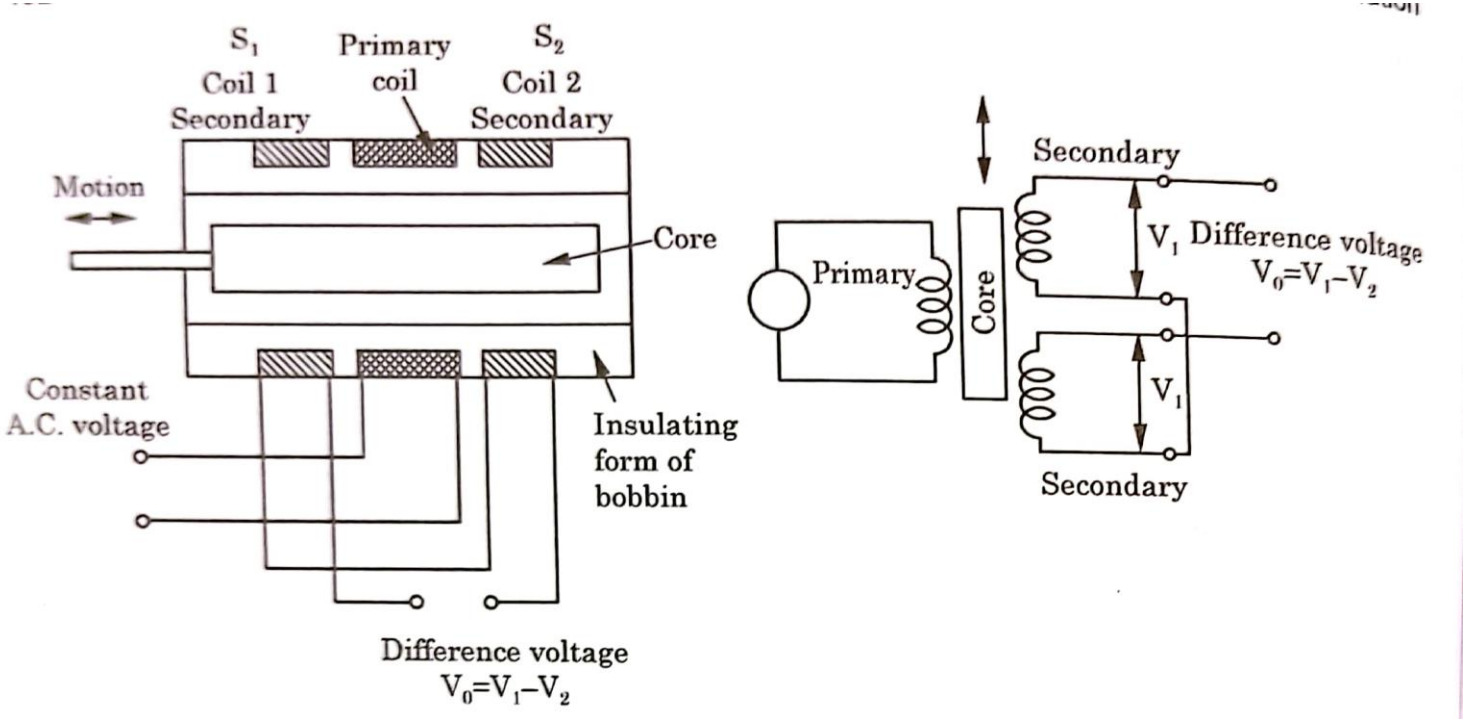



Refer to book for other tachometers and for more details

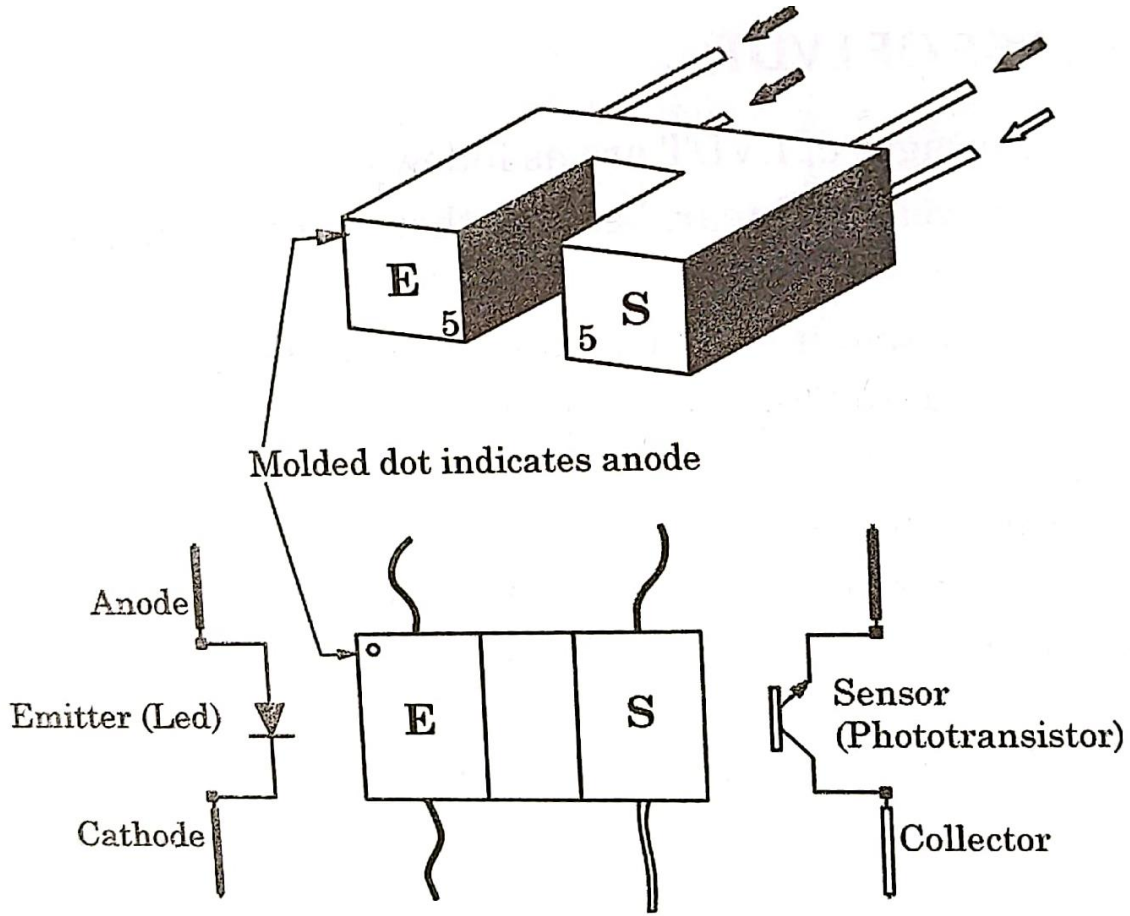
**LVDT**: LVDT is an acronym for linear variable differential transformer, a common type of electromechanical transducer that can convert the rectilinear motion of an object to which it is coupled mechanically into corresponding electrical signal.

**Principal of LVDT**: - Based on mutual induction.

**Construction of LVDT**: - It consists of cylindrical former where it is surrounded by one primary winding in the center of former and the two secondary winding at the slides. Number of turns in both the secondary winding are same but they are opposite to each other.



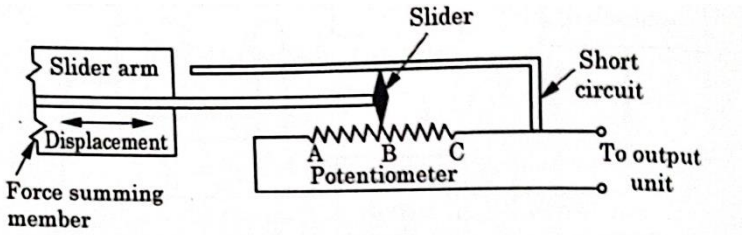
**Opto Interrupter**: Opto interrupter are small sensors, used to detect the presence or an absence of object. The sensors are typically ‘U’ shaped, and contain an infrared LED and a phototransistor responsive in the infrared band.

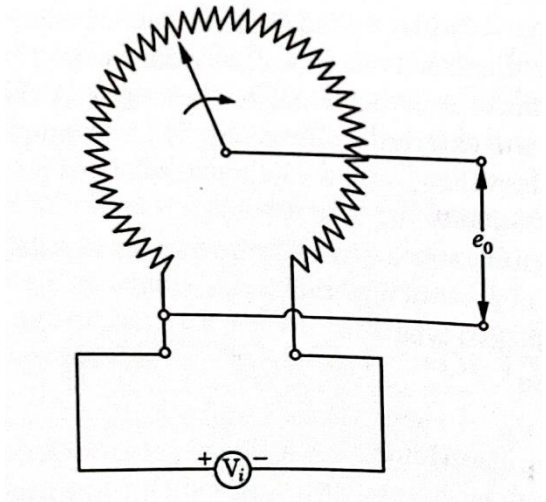


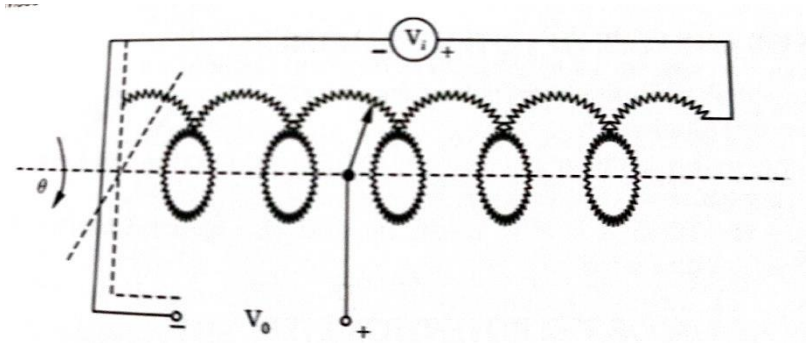
**Potentiometer**: It is a resistive sensor used to measure linear displacement as well as rotary motion. It consists of resistive material whose resistance is proportional to its length.

## Type of Potentiometer

- Linear Type
- Rotational Type
- Helix Type



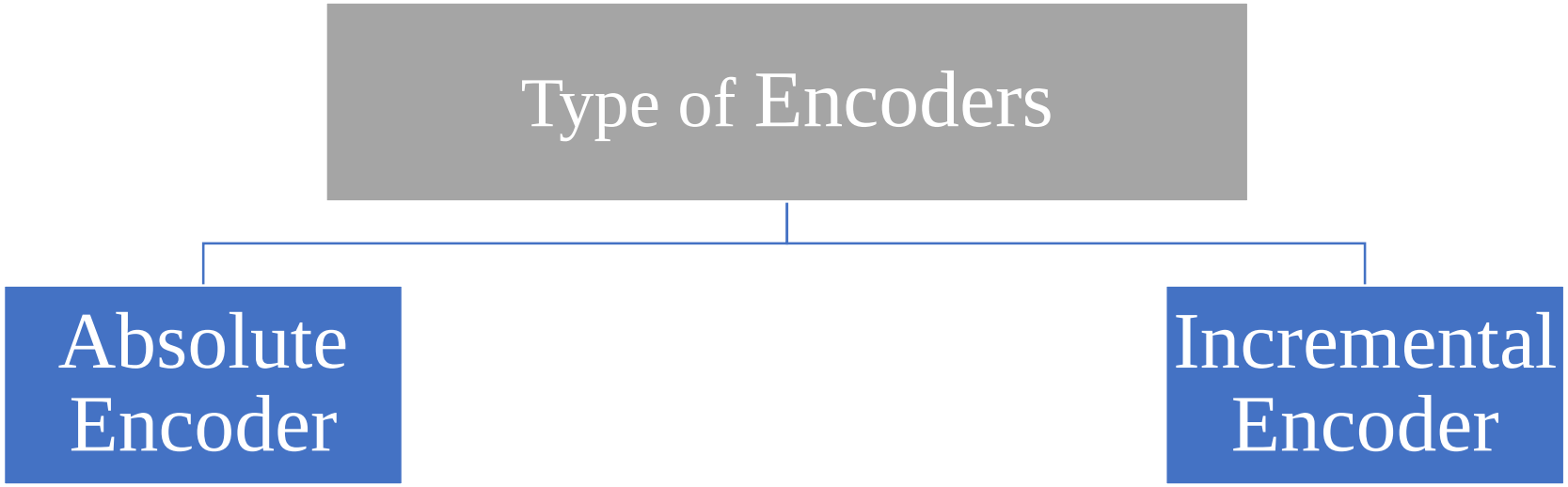
**Advantages**

1. These are inexpensive
2. Easy to use
3. High amplitude output
4. Easily available
5. High efficiency

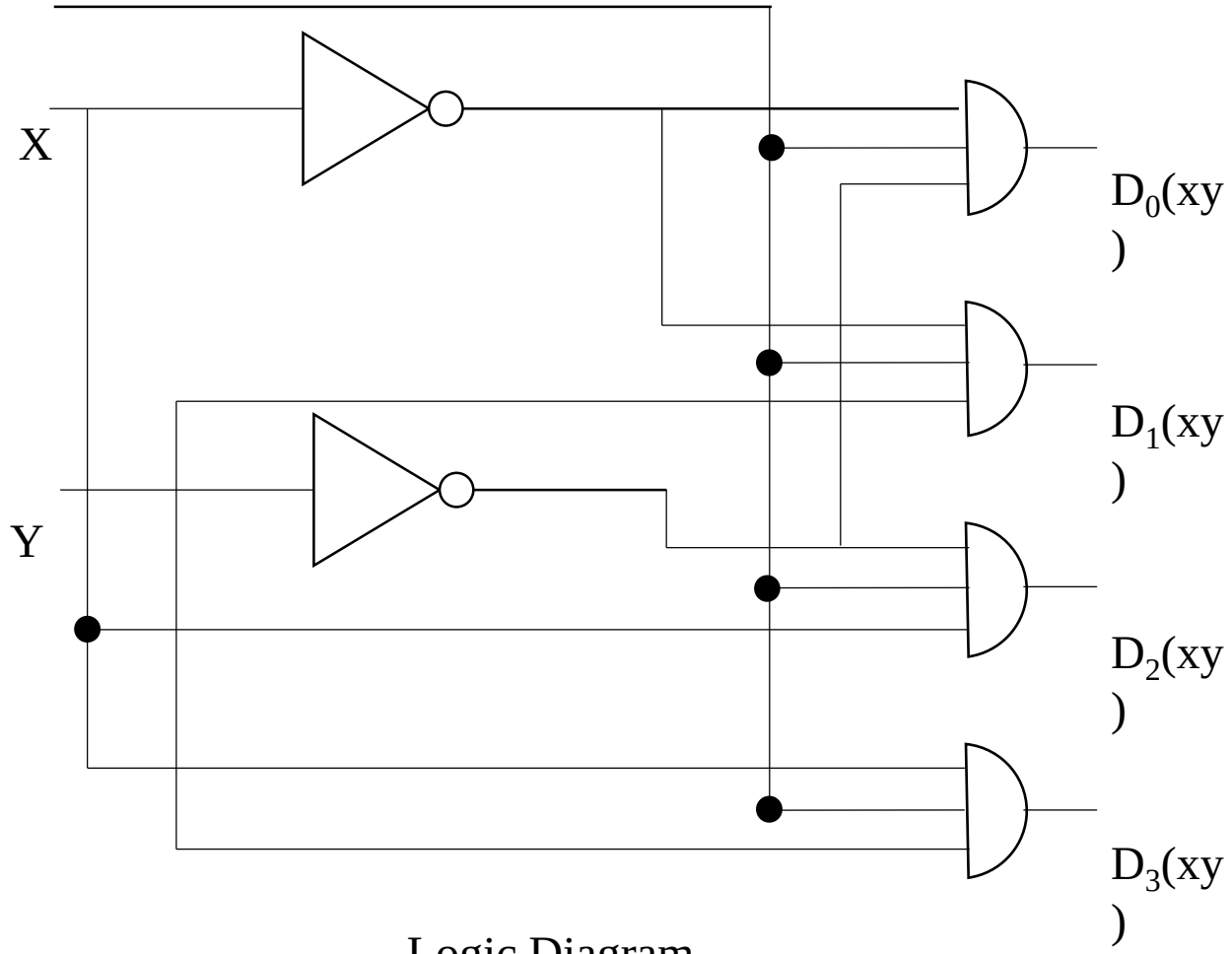
**Disadvantages**

1. Limited bandwidth
2. A large force is required in linear potentiometer
3. Friction and wear due to sliding across the resistive element

**Encoders:** An encoder is a device which apples a code or changes information into a code form. An optical encoders converts the rotary motion into a sequence of digital pulses. These pulses are counted and converted into absolute or incremental position measurement



**Decoder:** A decoder converts (decodes) binary information from one coded to another. The decoders to discussed here are called $2^n$ decoders with n input variables and $2^n$ output variables, where for each combination of binary input there is one and only one output line that will be 1.




Logic Diagram

Truth Table

| X | Y | $D_0$ | $D_1$ | $D_2$ | $D_3$ |
|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 |

**Axis Drives:** These system are used to provide motion to the parts, which are mounted on the machine to move along the different axis.

**Requirements of Axis Drives**

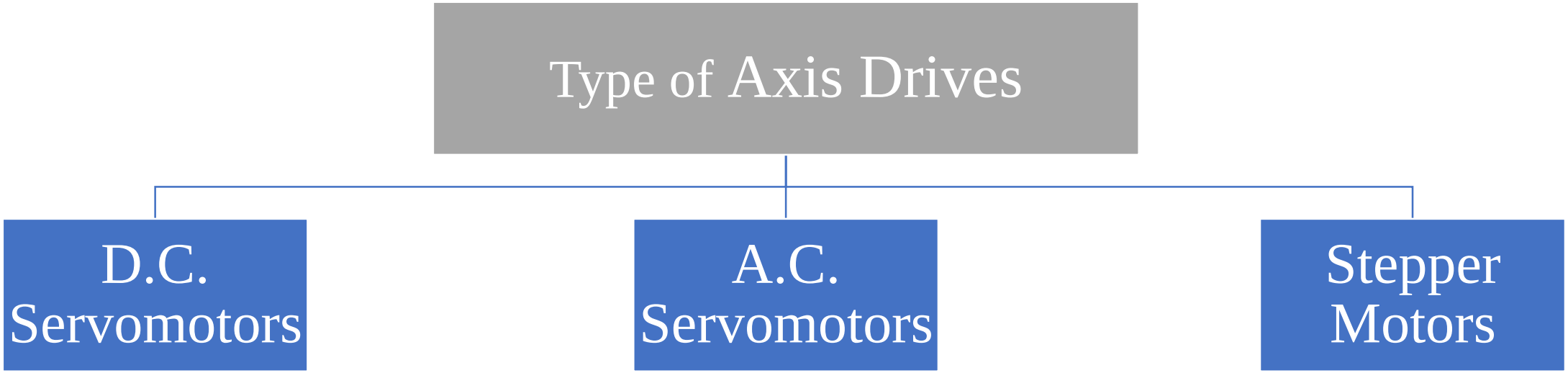
i) They required constant torque.

ii) Large speed variation range 1:20,000.

iii) Low electrical and mechanical time constants.

iv) Feedback devices should be integral.

v) Positioning of smallest positions increment should be possible.



# Thank You