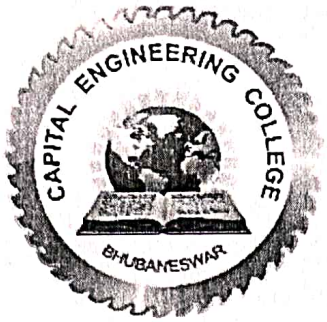

Department of Mechanical Engineering
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LECTURE NOTES

Name of the Subject: Mechatronics

Semester: 5th **Year:** 3rd

Name of the Faculty: Ananda Kumar Sahoo

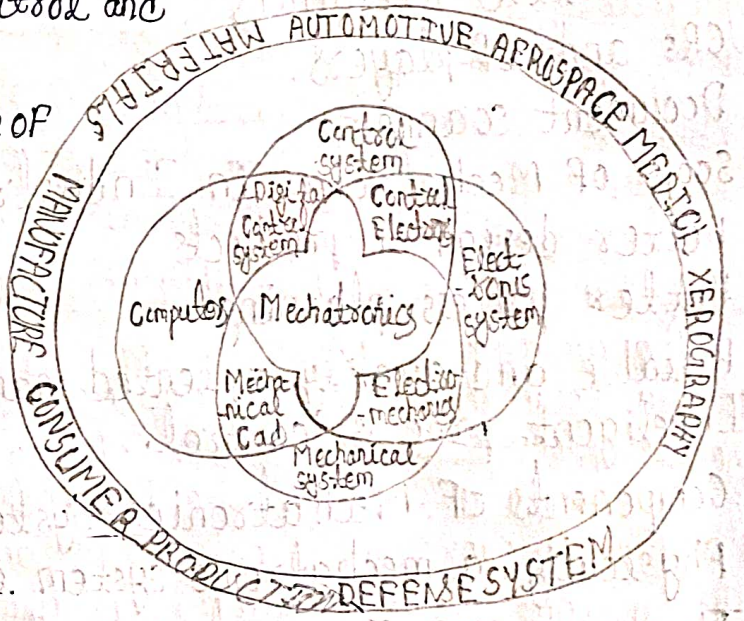
CHAPTER-1 INTRODUCTION TO MECHATRONICS

→ Defination of mechatronics
→ Advantages & dis advantages of mechatronics
→ Application of mechatronics
→ Scope of mechatronics in industrialsector
→ Components of a mechatronics system
→ Importance of mechatronics in automation

Defination of Mechatronics

* Mechatronics, also called mechatronics engineering, is an interdisciplinary branch of engineering that focuses on the integration of mechanical, electronic and electrical engineering systems, and also includes a combination of robotics, electronics, computer, Science, telecommunication, systems, control and product engineering.

* It is the extension and the completion of mechanical systems with sensor and microcomputer which is the most important aspect.



→ Advantages & Dis advantages of Mechatronics

* Advantages
- High level of integration.
- Increased functionally and better design.
- More use of electronics and software instead of mechanical function.
- Assumes responsibility for process and operation with little interference
- Use artificial intelligence and intelligent process control.
- High reliability and safety.
- Improved and less expensive controls.

→ Disadvantages
- The initial cost is very high.
- The complicated design and system.
- The repair and maintainance is complere.
- Its replacement is so difficult, that it is difficult to change the old system to the new system.

→ Application of Mechatronics
- Electronic home appliances
- Electronic entertainmaint products.
- Engine systems (cars)
- Large scale application
- Automotive mechanics
- VCRs and CD players.
- Document scanner.

→ Scope of Mechatronics In Industrial Sector
- Better design of products
- Better process planning
- Reliable and quality oriented manufacturing.
- Inteligent process control.

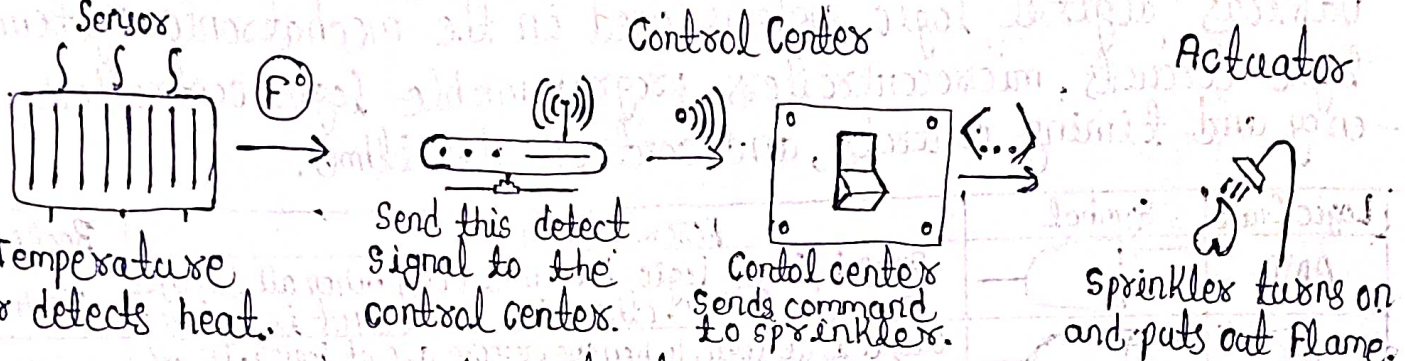
→ Components of Mechatronics System
- Physically, a mechatronic system is composed of four prime components. They are sensors, actuators, controllers and mechanical components.

(i) Actuators and sensors
(ii) Signals and conditioning
(iii) Digital logic systems
(iv) Software and data acquisition systems
(v) Computers and display devices

(i) Sensor and actuators

Sensor and actuators mostly come under mechanical systems. The actuators produce motion or cause some actions. The sensor detect the state of the system parameters, inputs and outputs. The various actuators used in the mechatronics system are pneumatic and hydraulic actuators, electro-mechanical actuators, electrical motors such as DC motors.

AC motors, stepper motors, servomotors and piezoelectric actuators. The various types of sensors used in the mechatronic system are linear and rotational sensors, acceleration sensors, force, torque and pressure.

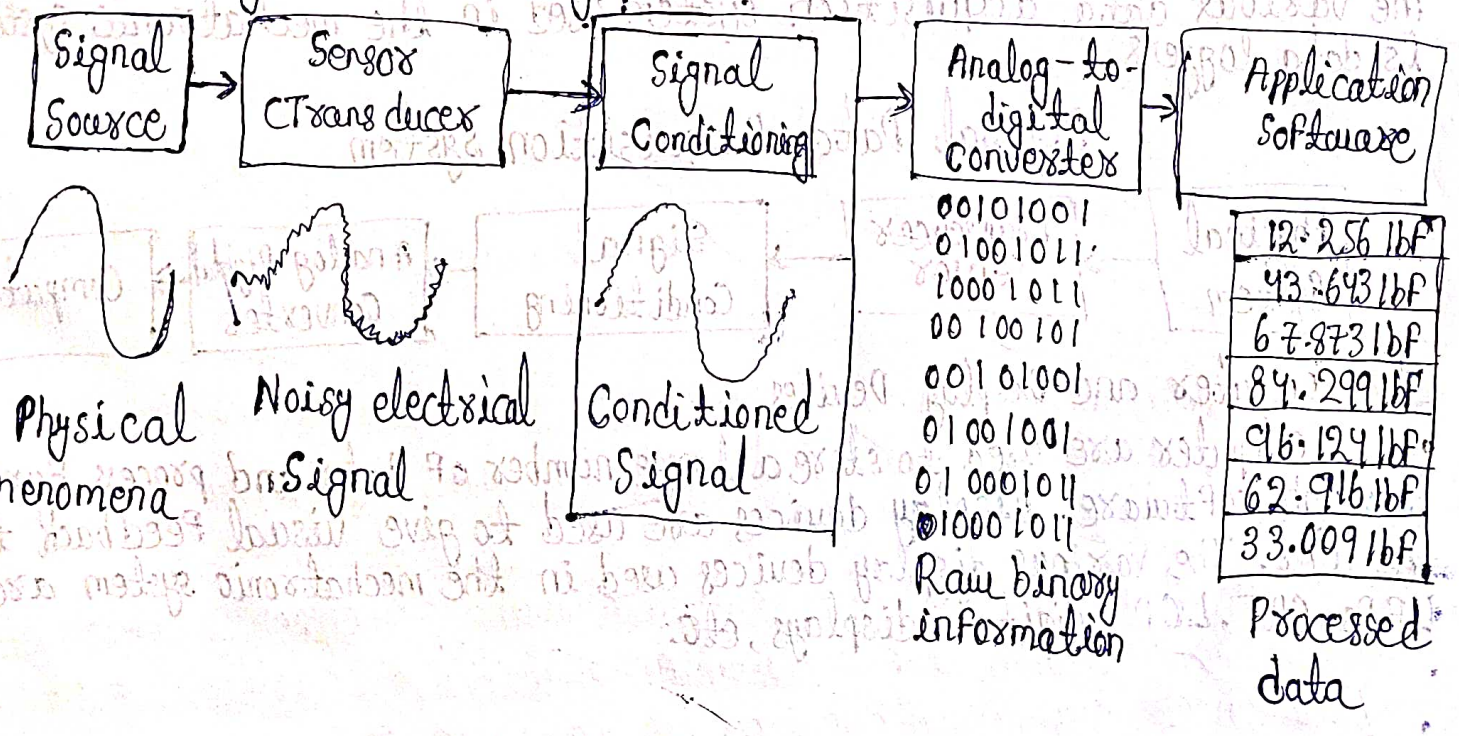


Sensor to actuator Flow

(ii) Signals and conditioning

The mechatronics systems deal with two types of signals and conditioning such as - input and output. The input devices recive input signals from the mechatronic system via interfacing devices and sensors. Then it is sent to the control circuits for conditioning or processing. The various input signal conditioning devices used in the mechatronic system are discrete circuits, amplifiers, Analog-to-digital (A/D) converters, Digital-to-Digital (D2D) convertors. The output signals from the system are digital output/display devices through interfacing devices. The various output signal conditioning devices used in the mechatronic system are digital-to-analog (D/A) converters, Display Decoders (DD) converters, amplifiers, Power transistors, and power op-amps.

What is signal Conditioning?



(iii) Digital logic System

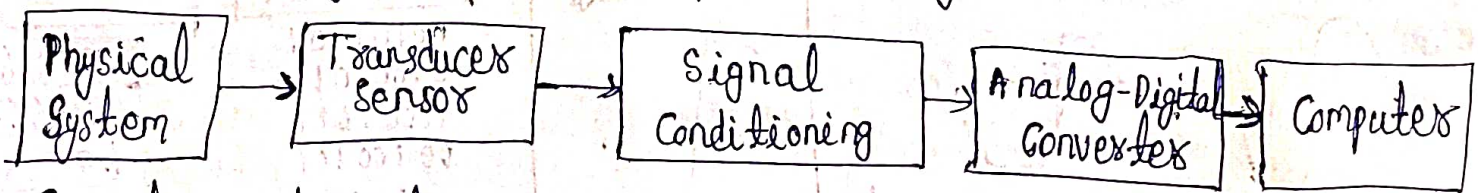
- Digital logic devices control overall system operation. The various digital logic systems used in the mechatronic system are logic circuits, microcontrollers, programmable logic controllers, sequ-ency and timing controls, and control algorithms.

Logic Gate	Symbol	Description	Boolean
AND		Output is at logic 1 when and only when all its inputs are at logic 1. otherwise the output is at logic 0.	$X = A \cdot B$
OR		Output is at logic 1 when one or more are at logic 1, IF all inputs are at logic 0. output is at logic 0.	$X = A + B$
NAND		Output is at logic 0. When and only when all its inputs are at logic 1. otherwise, the output is at logic 1.	$X = \overline{A \cdot B}$
NOR		Output is at logic 0 when it inputs are at logic 1. inputs are logic 0. out put is at logic 1.	$X = \overline{A + B}$
XOR		Output is at logic 1. when one and only its inputs is at logic 1. otherwise is it logic 0.	$X = A \oplus B$
XNOR		Output is at logic 0 when one and only one of its inputs is at logic 1. Otherwise is it logic 1 Invested.	$X = \overline{A \oplus B}$
NOT		Output is at logic 0 when its only input is at logic 1. and at logic 1 when its only input is at logic 0. thats why is called and INVERTER.	$X = \overline{A}$

(iv) Software and Data Acquisition Systems

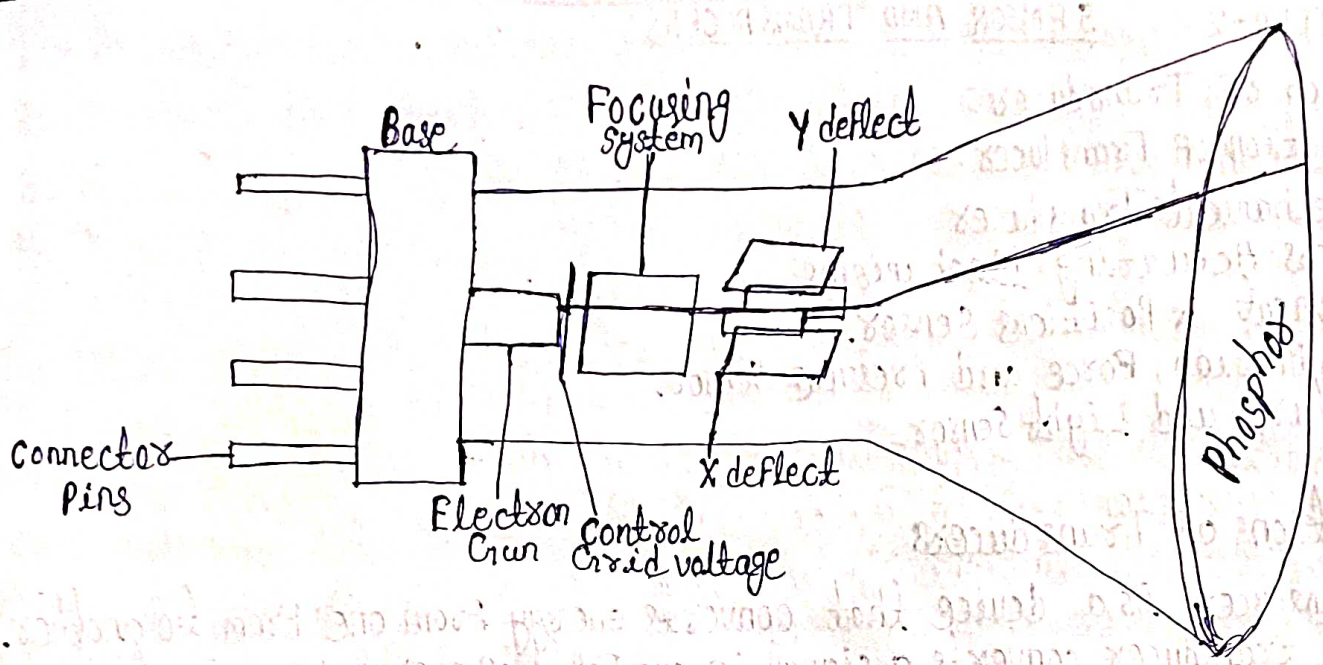
The data acquisition system acquires the output signals from sensors in the form of voltage, frequency, resistance etc. and it is inputted into the microprocessor or computer. Software is used to control the acquisition system of data through the DAC board. The data acquisition system consist of a multiplexer, amplifiers, registers and control circuitry., and DAC board. The various data acquisition system used in the mechatronic system is data loggers.

Digital Data Acquisition System



(v) Computer and Display Devices

- Computer are used to store a large number of data and process further through software. Display devices are used to give visual feedback to the user. The various display devices used in the mechatronic system are LEDs, CRT, LCD, digital displays, etc.



→ Importance of Mechatronics In Automation

- Mechatronics based automated systems such as automatic inspection and quality assurance, automatic packing, record making, and automatic dis-patch help to expedite the entire manufacturing operation.
- These systems certainly ensure a supply better quality, well packed and reliable products in the market.
- Mechatronics and automation is an integrative branch of engineering that incorporates learning principles from mechanical, Electrical, control, Robotics, Electronics, Computer, Telecommunication, System, and product Engineering.

END

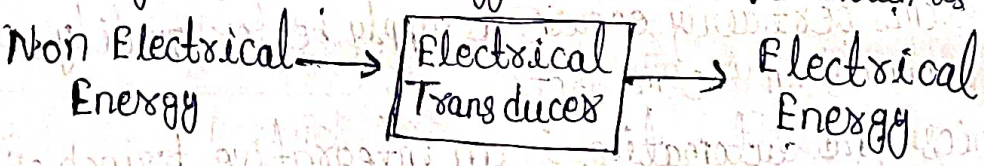
CHAPTER-2 SENSOR AND TRANSDUCERS

→ Defination of Transducer.
→ Classification of Transducer.
→ Electromechanical Transducer.
→ Transducer Actuating Mechanisms.
→ Displacement & Positions Sensor.
→ Velocity, Motion, Force and Pressure Sensor.
→ Temperature and Light Sensor.

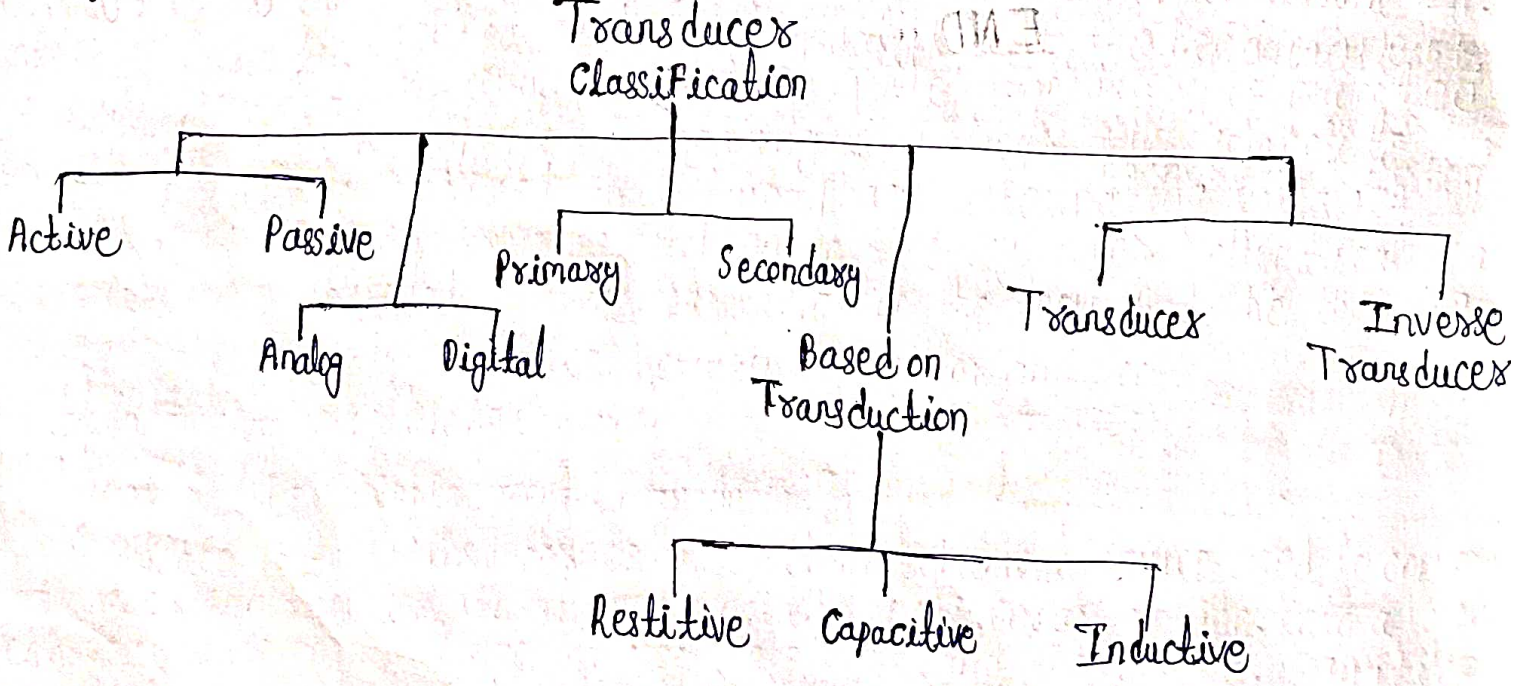
→ Defination of Transducer

- A transducer is a device that converts energy from one from to another. Usually a transducer converts a signal in one form of energy to a signal in another.

Transducer are often employed at the boundaries of automation, measurement and control system, where electrical signals are converted to and from other physical quantities (energy, force, torque, light, motion, position, etc). The process of converting one form of energy to another is known as transduction.



→ Classification of Transducer



- Classification of Transducer: There are many principles on which a transducer can work like resistive, inductive, capacitive etc. So transducer can be categorized on the basis of four thoughts. On the basis a transduction form its used .. we can go further

1. Primary and Secondary type
2. Analog and digital type
3. Active and passive type
4. Transducer and Inverse type

1. Primary and Secondary Transducer:

Suppose you need to measure pressure. In this case we use bourdon tube. So bourdon tube acts as primary transducer; it senses the pressure and converts pressure into displacement of its free end. The displacement of the free end moves the core of the linear variable differential transducer which produces output voltage proportional to movement of core which again proportional to pressure. So we are able to measure pressure. Here bourdon tube is the primary transducer and LVDT is secondary transducer.

2. Analog and Digital Transducer

Transducers converting input quantity to analog output in the form of pulses are analog transducers. I.E, strain gauge, thermocouple etc. Digital transducers convert input to electrical output in form of pulses.

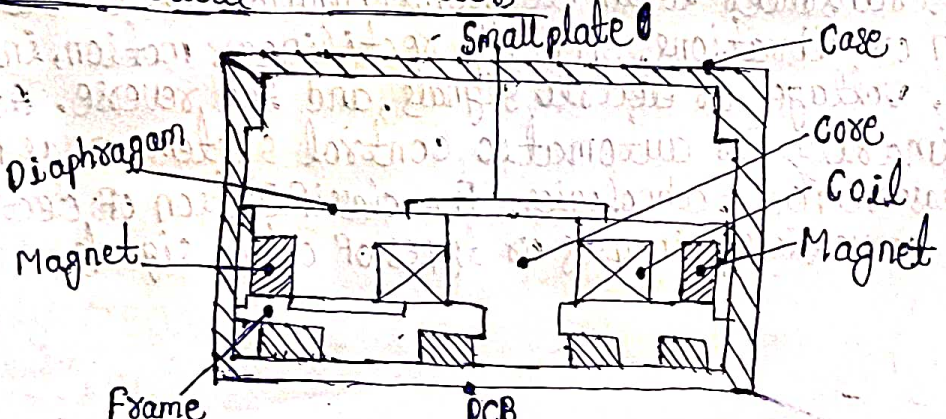
3. Active and Passive Transducers

Active transducers are those which don't need auxiliary power sources to produce output. The energy required for production of output signal is obtained from physical quantities being measured. I.E. piezoelectric crystals, tachogenerators etc. Passive transducers are those which need an auxiliary power source to produce output.

4. Tansducer and Inverse Transducer:

Transducer, as mentioned earlier convert non electrical quantity to electrical quantity whereas inverse transducer converts electrical to non-electrical quantity. This type of transducer converts electrical signals into required from. I.E. Piezoelectric crystal. It converts electricals signals into mechanical vibration.

Electromechanical Transducers



Dielectric elastomer (DE) are electromechanical transducers that converts or transduce electrical energy to or from mechanical energy. In an actuator mode, DEs convert electrical to mechanical energy, where as in a generator mode they perform the reverse function and convert mechanical to electrical energy. The chapter derives the Fundamental equation describing DE transduction. The equations show quantitatively how electrical parameters such as electric field and dielectric constant are related to mechanical parameters such as stress and strain. The basic equation can be extended to examine more suitable consideration such as Film ability and leakage, as well as applied to devices such as sensor and variable stiffness devices that transduce mechanical energy both to and form electrical energy.

Transducers Actuating Machine

Transducer are also known as gauges, pick up and signal generators.

1. Activating Devices
2. Transducing Elements

In order to excite a travelling wave in the cylinder, two standing waves, the amplitudes of which are equal, and their phase difference on time and space is $\pi/2$, are generated by the longitudinal and bending vibration of the transducer, respectively. The longitudinal vibration of the transducer is excited by the longitudinal vibration of longitudinal PZT. The bending PZT is located at the antinodal plane of the bend wave of the transducer, and the bending vibration of the transducer is excited by the longitudinal vibration of bending PZT. Thus, the composite transducer should be excited with two-phase alternating voltages. When a flexural traveling wave is excited in the cylinder elliptical trajectories are achieved at the particles on the teeth. And the driving force is the frictional force between the rotor and teeth.

Displacement & Positions Sensor

What is the Displacement Transducer?

A displacement transducer is an electromechanical device used to convert mechanical motion or vibrations, specially rectilinear motion, into a variable electrical current, voltage or electric signals, and the reverse. Actuating mechanisms used primarily for automatic control systems or as mechanical motion sensors in measurement technologies. The classification of electromechanical transducers includes conversion principles or types of output signals.

What is position transducer?

A position transducer typically consists of two fundamental parts. One part remains fixed in position while the other part moves with the mechanism whose displacement is being measured. The exact measure nature, and therefore the size, of fixed and moving portions depend on the sensing technology being used. Some transducers are intended to be mounted integrally to the mechanism, while others are designed to be mounted externally.

Velocity, motion, force and pressure sensors

→ Velocity Sensors

A velocity sensor receiver (velocity sensor) is a sensor that responds to velocity rather than absolute position. For example, dynamic micro-phones are velocity receivers. Movement causes the coil to move relative to the magnet, which in turn generates a voltage that is proportional to the velocity of that movement.

→ Motion Sensors

A motion sensor (or motion detector) is an electronic device that is designed to detect and measure movement. Motion sensors are used primarily in home and business security systems, but they can also be found in phones, paper towel dispensers, game consoles, and virtual reality systems. Unlike many other types of sensors (which can be handled and isolated), motion sensor are typically embedded systems with three major components:

a sensors unit, an embedded computer, and hardware (or the mechanical component).

→ Force Sensors

A force sensor is defined as a transducer that converts an input mechanical load, weight, tension, compression or pressure into an electrical output signal (load cell definition). Force sensors, are also commonly known as force transducers. There are several types of load cells based on size, geometry and capacity.

→ Pressure Sensor

A pressure sensor is a device for pressure measurement of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts a transducer; it generates a signal as function of the pressure imposed. For the purposes of this article, such a signal is electrical. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude.

Pressure sensors can alternatively be called pressure transducer, pressure transmitters, pressure senders, pressure indicator piezometer and manometers among other names.

⇒ Temperature and Pressure Sensors

Temperature sensors is a device used to measure temperature. This can be air temperature, liquid temperature or the temperature of solid matter. They are different types of temperature sensors available and they each use different technologies and principles to take the temperature measurement.

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes. They are many different types of temperature sensors. Some temperature sensors require direct contact with the physical object that is being monitored (contact temperature sensors), while other indirectly measure the temperature of an object (non-contact temperature senses).

⇒ Light Sensor

The light sensor generates an output signals indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called light and which range in frequency from Infrared to visible up to Ultraviolet light spectrum.

The light sensor is a passive device that converts the light energy into an electrical signal output. Light sensors are more commonly known as photoelectric. Device or photo sensors because they convert light energy (Photons) into electronic signals (electrons) The sensor receives the light reflected from the target.

The light sensor is a passive device that converts this light energy whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as (Photoelectric Devices' or (Photo sensors) because they convert light energy (Photons) into electricity (electrons).

END

CHAPTER-3 Actuators - Mechanical, Electrical

Mechanical Actuators

Machine, Kinematic Link, Kinematic pair

Mechanism, Slider crank mechanism. Gear drive, spur gear, Bevel gear, Helical gear, wormgear Belt & Belt drive. Bearings.

Electrical Actuators

Switches and relay
Solenoid
D.C. motors
A.C. motors

Specification and control of stepper motor

Servo Motors D.C & A.C

Mechanical Actuators

Machine, Kinematic link, Kinematic pair

Machine :- A machine (or mechanical device) is a mechanical structure that uses power to apply forces and control movement to perform an intended action.

An apparatus using mechanical power and having several parts, each with a definite function and together performing a particular task.

Kinematic Link :- It is defined as the part of machine which has a relative motion with respect to some other part of same machine is called kinematic link or element.

In mechanical engineering, a kinematic chain is an assembly of rigid bodies connected by joints to provide constrained motion that is the mathematical model for a mechanical system.

Kinematic Pair:- The two links or elements of a machine, when in contact with each other, are said to form a pair. If the relative motion between them is compeletly or saccesfully constrained the pair is known as kinematic pair.

The two links or elements of a machine, when in contact with each other, are said to form a pair. If the relative motion between them is completely or successfully constrained (i.e. in a definite direction), the pair is known as kinematic pair.

Mechanism, Slider crank Mechanism

A mechanism is usually a piece of a larger process, known as a mechanical system or machine. Sometimes are entire machin may be refered to as a mechanism; examples are the steering mec -anism in a car, or the winding mechanism of a wristwatch.

The way in which the parts of a machine are interconnected and guided to produce a required output motion from a given input motion is known as the mechanism of the machine.

Slider-crank mechanism

Arrangement of mechanical parts designed to convert straight-line motion to rotary motion, as in a reciprocating piston engine, or to convert rotary motion to as in a reciprocating piston pump. The basic nature of the mechanism and the relative motion of parts.

Slider-crank mechanism, arrangement of mechanical parts designe to convert straight-line motion to rotary motion, as in a reciprocating piston engine, or to convert rotary motion to straight-line motion, as in a reciprocating piston pump.

Crear drive, Spur gear, Bevel gear, Helical gear, worm gear.

Crear drive

Same sized and shaped teeth cut at equal distances along a flat surface or a straight rod is called a gear rack. A gear rack is a cylindrical gear with the radius of the pitch cylinder being infinite. By meshing with a cylindrical gear pinion, it converts rotational motion into linear motion. Crear racks can be broadly divided into straight tooth racks and helical tooth racks, but both have straight tooth lines. By machining the ends of gear racks, it is possible to connect gear racks end to end.

Spur gear:

Gears having cylindrical pitch surfaces are called cylindrical gears. Spur gears belong to the parallel shaft gear group and are cylindrical gears with a tooth line which is traight and parallel to the shaft. Spur gears are the most widely used gears that can achieve high accuracy with relatively easy production processes. They have the characteristics of having no load in the axial direction (thrust load). The larger of the meshing pair is called the gear and smaller is called pinion.

Bevel gear

Bevel gears have a cone shaped appearance and are used to transmit force between two shafts which intersect at one point (intersecting shafts). A bevel gear has a cone as its pitch surface and its teeth are cut along the cone. Kinds of bevel gears include straight bevel gears, miter gears, angular bevel gears, crown gears, zerol bevel gears and hypoid gears.

Helical gear

Helical gears are used with parallel shafts. similar to spur gear and are cylindrical gears with winding tooth lines: They have better teeth meshing than spur gears and have superior quiteness and can transmit higher loads, making them suitable for high-speed applications. When using helical gears, they create thrust force in the axial direction, necessitating the use of thrust bearings. Helical gears come with right hand and left hand twist requiring opposite hand gears for a meshing pair.

Worm gear

A screw shape cut on a shaft is the down, the mating gear is the worm wheel, and together on non-intersecting shafts is called a worm gear. Worms and worm wheels are not limited to cylindrical shapes. There is the hour-glass type which can increase the contact ratio, but production becomes more difficult. Due to the sliding contact of the gear surfaces, it is neccessary to reduce friction. For this reason, generally a hard material is used for the worm, and a soft material is used for worm wheel. Even though efficiency is low due to the sliding contact, the rotation is smooth and quite. When the lead angle of the worm is small, it creates a self-locking feature.

Belt & Belt drive

Belt:

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement, and the shafts need not be parallel.

In a two-pulley system, the belt can either drive the pulleys normally in one direction, or the belt may be crossed, so that the direction of the driven shaft is reversed. The belt drive can also be used to change the speed of rotation, either up or down, by using different sized pulleys.

Belt drive:

Belt drive, machinery, a pair of pulleys attached to usually parallel shafts and connected by an encircling flexible belt (band) that can serve to transmit and modify rotary motion from one shaft to other. Most belt drives consist of flat leather, rubber, or fabric running on cylindrical pulleys or of belts with V-shaped cross sectio running on grooved pulleys. To create an effective frictional grip on the pulleys. Flat and V belts slip when overloaded, and in some applicatio this conditions may be more desirable than a rigid drive because it limit the transmitted torque and may prevent breakage of parts.

Bearings

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Other bearings are separate devices installed into a machine or machine part. The most sophisticated bearings for the most demanding applications are very precise devices; their manufacture requires some of the highest standards of current technology.

Electrical Actuators

→ Switches and relay

- Switches

A switch is an electromechanical device used to make or break the circuits.

* Switches can be controlled mechanically.
* It controls the flow of current by operating or closing circuits.
* They are operated manually by a lever or by pushing the buttons.
* It is used to open or close the contacts.
* It operates slowly when compared to relay because it requires a physical object to make the changes.
* A switch makes a direct contact or connection.
* Example: Mannual control of switch. (Physical controls of fan).

→ Relay:-

* Relay is an electromechanical device used to make or break the circuits.
* Relays can be controlled electronically.
* It controls high power circuits with low power signals by opening or closing the contacts.
* It can send electro magnetic or optical signal to actuate the load circuit
* It is used to protect the system from damage.
* It operates faster.
* It is a remote control switch.
* Example: To turn ON/OFF Air conditioner, LDR street light.

Solenoid

A solenoid is a device comprised of a coil of wire, the housing and a movable plunger. When an electrical current is introduced, a solenoid converts electrical energy into mechanical work.

- The coil is made of many turns of tightly wound copper wire. When an electrical current flows through this wire, a strong magnetic field/flux is created.
- The housing, usually made of iron or steel, surrounds the coil concetrating the magnetic field generated by the coil.
- The plunger is attracted to the stop through the concentration of the magnetic field providing the mechanical force to do work

When an electrical current is introduced, a magnetic field forms around the coil which draws the plunger in. More simply, a solenoid converts electrical energy into mechanical work.

D.C. Motors

A DC motors is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types relay on the forces produced by magnetic fields. Either electromechanical or electronic, to periodically change the direction of current in part of the motor.

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motors speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Larger DC motors are currently used in propulsion of electric vehicles, elevators and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

A DC motors is defined as a class of electrical motors that convert direct-current electrical energy into mechanical energy.

From the above definition, we can conclude that any electric motor that is operated using direct current or DC is called a DC motor. We will understand the DC motor construction and how a DC motor converts the supplied DC electrical energy into mechanical energy in the next few sections.

A.C. Motors

An AC motors is an electric machine that converts alternating current into mechanical rotation. AC motors applications range from industrial bulk power conversion from electrical to mechanical to household small power conversion.

An AC motors is a motor that converts the alternating current into mechanical power. The sator is the stationary part of the motor, and the rotor rotating part of the motor.

Nikola Tesla inverted the first AC induction motor in 1887. The AC motor may be single-phase or three-phase.

The two main types of AC motors are induction motors and synchro-nous motors. The induction motor always relies on a small difference in speed between the stator rotating magnetic field and the rotor shaft speed called slip to induce rotor current in the rotor AC winding.

Specification and Control of stepper motor

- Size: 42.3mm square X48mm, not including the shaft.
- Weight: 350g (13 oz)
- Shaft diameter: 5mm "D"
- Steps per revolution: 200
- Current rating: 1.2A per coil
- Voltage rating: 4V
- Resistance: 3.3Ω per coil.
- Holding torque: 3.2 Kg-cm (44 oz-in)
- Inductance: 2.8 mH per coil.
- Lead length: 30cm (12")
- Output shaft supported by two ball bearings.
- Control of stepper motor

Stepper motor control constant voltage drives are used to apply a constant positive or negative volatage to each winding to drive motion. However, it is winding current, not voltage, that applies torque to motor shaft. Thus, these are also known as L/R drives. To obtain high torque at high speeds requireds a large drive voltage with a low resistance and low inductance. With an L/R drive it is possible to control a low voltage resistive motor with a higher voltage drive simply by adding an exeternal resistor in series with each winding. It is therefore considered a low-performing option.

Speed of a stepper motor can be controlled by changing its switching speed or by changing the length of the time delay loop.

Characteristics:

1. Rotation in both directions
2. Precision angular incremental changes
3. Repetetion of accurate motion or velocity profiles,
4. A holding torque at zero speed, and
5. Capability for digital control

A stepper motor can move in accurate angular increments known as steps in response to the application of digital pulses to an electric drive circuit from a digital controller. Generally, stepper motors are manufactured with steps per revolution of 12, 24, 72, 144, 180 and 200, resulting in shaft increament of 30, 15, 5, 2.5, 2 and 1.8 degree per step.

Stepper motors are either biopolar, requiring two power sources or a switchable polarity power source, or unipolar, requiring only one power source. Generally, stepper motors produce less than 1 horsepower (746 W) and are therefore frequently used in low-power positions control applications.

CHAPTER-4 Programmable logic controllers

- Introduction
- Advantages of PLC
- Selection and uses of PLC
- Architechture basic internal structure
- Input / Output processing and programming
- Mnemonics
- Master and Jump controllers

Introduction

A programmable logic controller (PLC) is a specialized computer used to control machines and process. Eliminates mush of the hard wiring that was associated with conventional relay control circuits. The program takes the place of mach of the external wiring that would be required for cntrl of a process.

PLC stands for programmable Logic controllers. They are basically used to control automated systems in industries. They are one of the most advanced and simplest forms of control systems which are now replacing hard-wired logic relays at a large scale.

The programmable logic controller, or PLC, is ubiquitous in process and manufacture industries today. Initialy built to replace electromechanical relay systems, the PLC offers a simpler solution for modifying the operation of a control systems. Rather than having to rewire a large bank of relays, a quick down load from a PC or programming device enables control logic changes in a matter of minutes or even seconds.

Advantages of PLC

Before getting into details about PLCs, let us known 3 reasons why PLCs are being widely used these days.

- They are user friendly and easy to operate.
- They eliminate they need for hard-wired relay logic.
- They are fast.
- It is suitable for automation in industries.
- Its input and output modules can be extends depending upon the requirements.

Selection and use of PLC

PLC are used in,

- Transportation system like conveyor belt system.
- Poking and labeling system in food & beverage.
- Automatic bottle or liquid filling system.
- Packing and labeling system in pharma industries.
- Transportation system like escalator and elevator.
- Industrial crane control system for operation of over loading Traveling crane
- Glass industries for glass production and recording data.
- Paper industries for the production of pages, Books or News papers etc.
- Cement industries for manufacturing or mixing the right quality and quantity of raw materials, and accuracy of data regarding.
- Automatic Drainage water pump monitoring and Controlling system.
- Time and count-based control based control system for an industrial machine.

Architecture basic internal structures