UNIT 1: 12M

1. INDUSTRIAL INTERENT SYSTEM

Industrial Internet system:

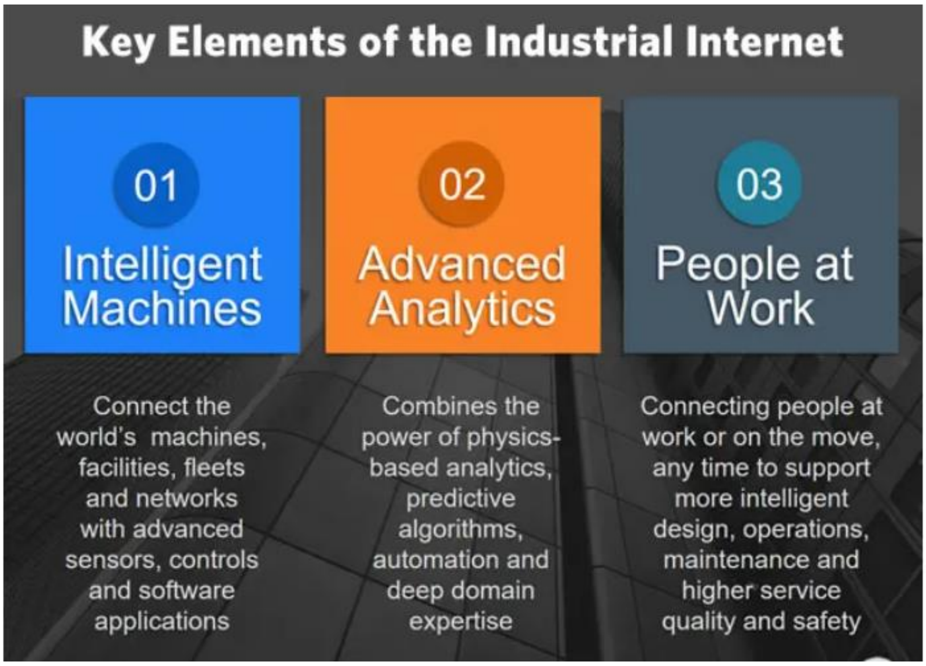
- The Industrial Internet is the integration and linking of big data, analytical tools and wireless networks with physical and industrial equipment, or otherwise applying meta-level networking functions, to distributed systems.
- The term was coined by General Electric (GE), a U.S. corporation.

Explains Industrial Internet:

- The Industrial Internet incorporates ideas of intelligent machines, or specific pieces of equipment, with embedded technology and the Internet of Things (IoT).

- Examples are pieces of machinery or vehicles that are equipped with intelligent technologies, including machine to machine (M2M) technologies that allow manufacturing equipment or other types of equipment to send data back and forth, or "talk among themselves."

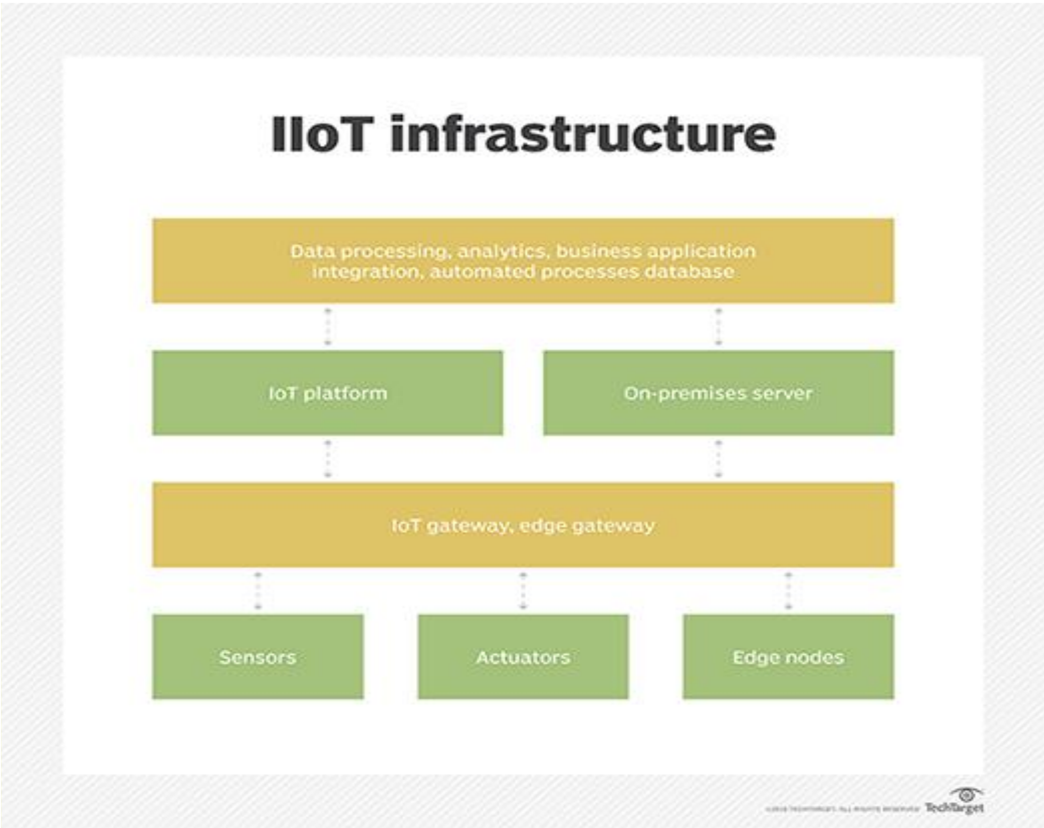
- The Industrial Internet also is applied to transportation projects, such as driverless (or autonomous) cars and intelligent railroad systems.



IIoT working

IIoT is a network of intelligent devices connected to form systems that monitor, collect, exchange and analyze data. Each industrial IoT ecosystem consists of:

- connected devices that can sense, communicate and store information about themselves;
- public and/or private data communications infrastructure;
- analytics and applications that generate business information from raw data;
- storage for the data that is generated by the IIoT devices; and
- people.



Benefits of IIoT

One of the top touted benefits of IIoT devices used in the manufacturing industry is that they enable predictive maintenance. Organizations can use real-time data generated from IIoT systems to predict when a machine will need to be serviced. That way, the necessary maintenance can be performed before a failure occurs. This can be especially beneficial on a production line, where the failure of a machine might result in a work stoppage and huge costs. By proactively addressing maintenance issues, an organization can achieve better operational efficiency.

Another benefit is more efficient field service. IIoT technologies help field service technicians identify potential issues in customer equipment before they become major issues, enabling techs to fix the problems before they inconvenience customers. These technologies might also provide field service technicians with information about which parts they need to make a repair. That way, the technician has the necessary parts with them when making a service call.

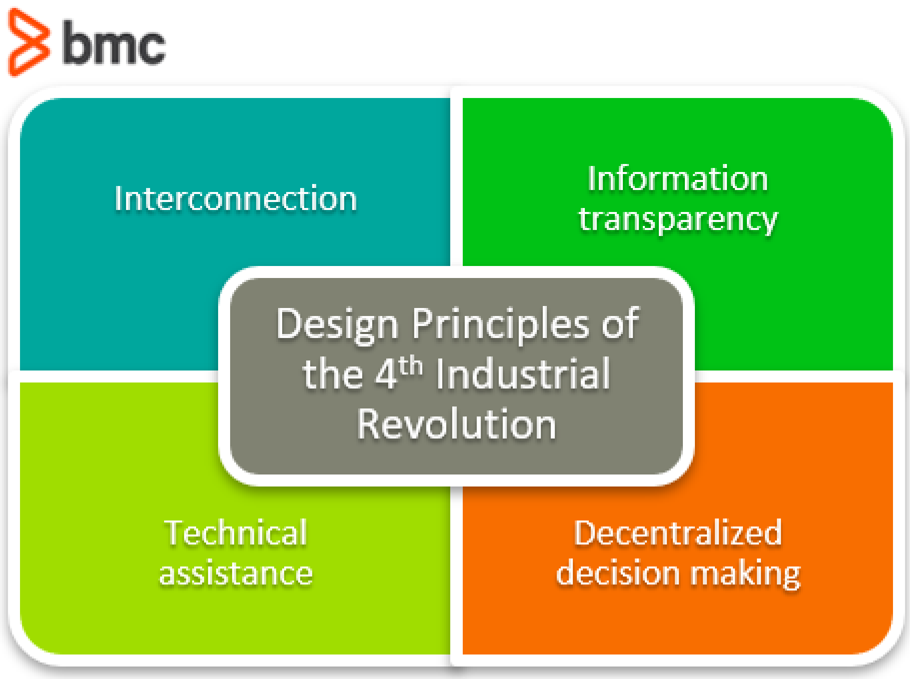
2. INDUSTRY 4.0:

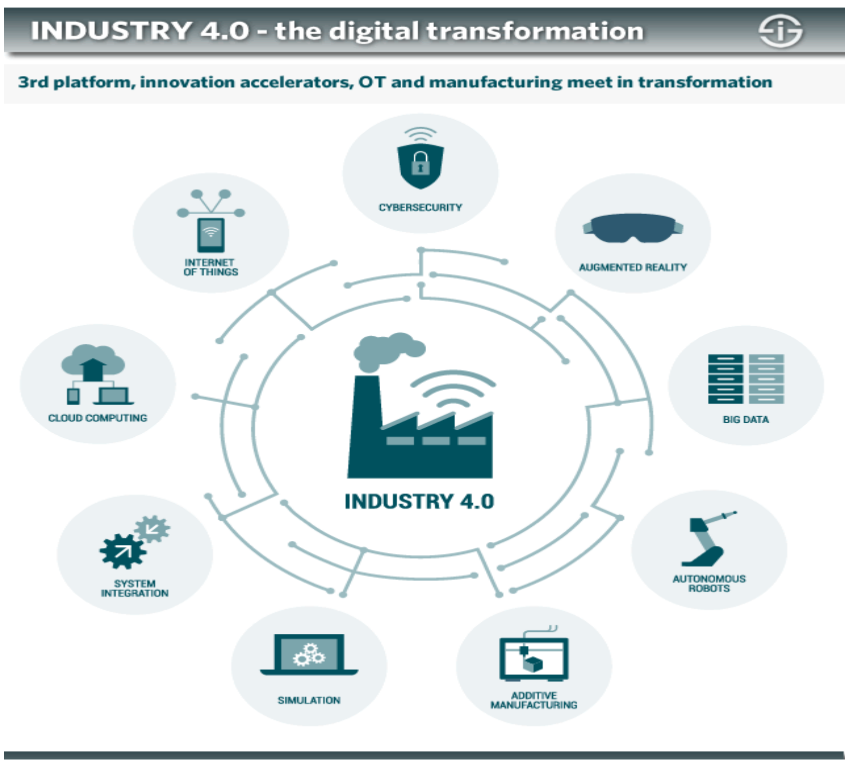
- Industry 4.0 is used interchangeably with the fourth industrial revolution and represents a new stage in the organization and control of the industrial value chain.
- Cyber-physical systems form the basis of Industry 4.0 (e.g., 'smart machines'). They use modern control systems, have embedded software systems and dispose of an Internet address to connect and be addressed via the Internet of Things (IoT).
- This way, products and means of production get networked and can 'communicate', enabling new ways of production, value creation, and real-time optimization.

- ➢ Cyber-physical systems create the capabilities needed for smart factories.
- ➢ These are the same capabilities we know from the Industrial Internet of Things like remote monitoring or track and trace, to mention two.

Fourth industrial revolution

- ➢ We are now in the fourth industrial revolution, also referred to as Industry 4.0. Characterized by increasing automation and the employment of smart machines and smart factories, informed data helps to produce goods more efficiently and productively across the value chain.
- ➢ Flexibility is improved so that manufacturers can better meet customer demands using mass customization—ultimately seeking to achieve efficiency with, in many cases, a lot size of one





Industry 4.0 is often used interchangeably with the notion of the fourth industrial revolution. It is characterized by, among others,

- even more automation than in the third industrial revolution,
- the bridging of the physical and digital world through cyber-physical systems, enabled by Industrial IoT,
- a shift from a central industrial control system to one where smart products define the production steps,
- closed-loop data models and control systems and
- personalization/customization of products.

Industry 4.0 is the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things and cloud computing. Industry 4.0 creates what has been called a "smart factory".

Industry 4.0 challenges and risks

- The definition of a strategy (for Industry 4.0), challenge number one.
- The rethinking of the organization and processes to maximize outcomes.
- Understanding the business case.
- Conducting successful pilots.
- Making the organization realize action is needed.
- Change management, so often overlooked.
- Company culture.
- A true interconnection of departments.

Industry 4.0 Technologies

Generally-speaking, Industry 4.0 describes the growing trend towards automation and data exchange in technology and processes within the manufacturing industry, including:

- The internet of things (IoT)
- The industrial internet of things (IIoT)
- Cyber-physical systems (CPS)
- Smart manufacture
- Smart factories
- Cloud computing
- Cognitive computing
- Artificial intelligence

3. Collaborative Platform and ANALYTICS FOR SMART BUSINESS TRANSFORMATION:

1.12 COLLABORATIVE PLATFORM AND PRODUCT LIFECYCLE MANAGEMENT

What is a collaborative platform?

A collaborative platform is a virtual workspace where resources and tools are centralized with the aim of facilitating communication and personal interaction in corporate project work. This naturally means providing access to information, but also and importantly, encouraging collaboration in project tracking directly via the platform about:

- Project updates, monitoring and management;

- Document sharing (spreadsheets, presentations, text files, etc.);
- Exchanging information and communication about initiatives in progress.

The aim of a collaborative platform is to enable staff to work better together by simplifying their project monitoring tasks and delivering efficiency gains. Such a platform is an **innovative solution for businesses seeking productivity, financial savings and enhanced employee well-being**.

Different types of platform exist, depending on the type of project concerned. Some solutions will adapt themselves to all projects, while others require some customization. In any event, it is advisable to choose the solution that meets your main objectives in terms of collaboration:

3.a)ANALYTICS FOR SMART BUSINESS TRANSFORMATION:

1.16ANALYTICS FOR SMART BUSINESS TRANSFORMATION.

What is analytic transformation in business?

Businesses that embrace analytics technology **transform their business models, and encounter new opportunities for customers, products, revenue streams, and services**. From sourcing materials and forecasting demand to the accounting and human resource activities, every aspect of the business can be with analytics.

2 Smart Analytics is **precisely analyzing in a smart and profitable manner all that volume of information**, which was impossible to do using traditional analysis methods. The goal behind Smart Analytics is to make the most out of all that information that is meaningless when served raw, but when correctly treated and analyzed, may imply a paramount change in the balance sheet of our company.

3 The smart analysis of Big Data is also **transforming the business world**. According to data presented by the CeBIT organization –the most important computer, information technology, telecommunications, software and services fair in the world– companies that use Big Data Analytics programs **are capable of making decisions five times faster** than those that do not work with Big Data. Moreover, 50% of the companies that do analyze Big Data ensure that this action lets them get a better grasp on consumer demand, boosting company growth.

Product Lifecycle Management (PLM)

Introduction to Product Lifecycle Management

Product lifecycle management, sometimes "product life cycle management", represents an all-encompassing vision for **managing all data relating to the design, production, support and ultimate disposal of manufactured goods**.

PLM concepts were first introduced where safety and control have been extremely important, notably the aerospace, medical device, military and nuclear industries. These industries originated the discipline of configuration management (CM), which evolved into electronic data management systems (EDMS), which then further evolved to product data management (PDM).

Over the last ten years, manufacturers of instrumentation, industrial machinery, consumer electronics, packaged goods and other complex engineered products have discovered the benefits of PLM solutions and are adopting efficient PLM software in increasing numbers.

The essential elements of PLM:

- Manages **design and process documents**
- Constructs and controls **bill of material** (product structure) records
- Offers an **electronic file repository**
- Includes built-in and custom **part and document metadata** ("attributes")
- Identifies **materials content for environmental compliance**
- Permits **item-focused task assignments**
- Enables **workflow and process management** for approving changes
- Controls **multi-user secured access**, including "electronic signature"
- Exports **data for downstream ERP systems**

4. Basic principles of design and validation of cps

1.9 BASIC PRINCIPLES OF DESIGN AND VALIDATION OF CPS

PRINCIPLES: INTEGRATING THE PHYSICAL AND CYBER

The core principle of CPS is the bridging of engineering and physical world applications and the computer engineering hardware and computer science cyber worlds. Basic principles of the physical world include elements of physics, modeling, and real-world intangibles such as uncertainty and risk. Concurrently, the principles of computer engineering and computer science worlds deal with embedded systems, networking, programming, and algorithms. CPS education thus goes beyond exposure to the traditional dynamical systems models (ordinary differential or difference equations) to an understanding of physical impacts not only at the physical layer, but also across the physical-cyber interface.

Sensors are an example of a hardware bridge between the physical and cyber worlds. They are the primary devices that collect data from the physical world that are then used as input to the cyber world. Understanding the properties and principles of sensors and how to use them in a manner that is aware of sensor and real-world constraints is critical. Unfortunately, high-level abstractions used to simplify system development often have the undesirable side effect of hiding key physical world principles that programmers need to know if the CPS they develop are to work properly. Once raw data are collected, they are processed via signal processing techniques. The required principles of signal processing include linear signals and systems theory, analog and digital filtering, time and frequency domain analysis, convolution, linear transforms like the discrete Fourier transform and fast Fourier transform, noise and statistical characterization of signals, machine learning, and decision and sensor fusion. In CPS, considerations of the implementations of these signal processing techniques on embedded CPUs, running in real time and with safety critical implications, are necessary, as is the topic of sensor reliability. Often these issues are not considered in classical signal processing courses.

Control is a central tenet of CPS. Relevant elements of control theory include stability and optimization as well as control techniques in the context of networks, hybrid systems, stochastic systems, and digital systems. Of particular importance in the cyber domain are the implications for control of distributed systems and the inherent delays they impose.

In today's networked, wireless, and real-time world, and as cyber-physical systems become embedded in our economy and society, knowledge of the principles underlying these topics is also necessary for CPS engineering. Areas where students need this knowledge include the following:

Communication and networking. CPS requires an understanding from physical-layer principles to protocols, layered architectures, and the many real-world properties of wireless communications.

Real time. An understanding of topics like real-time scheduling theory, temporal semantics in programs, and clock synchronization in networks is needed.

Distributed systems. The distributed and networked nature of CPS in many of the applications of interest should be included in CPS education. Even though distributed systems and networking are covered in traditional engineering or computer science curricula, these courses often do not address CPS issues. CPS combines the hardware implementation with the software that runs the algorithms, all operating in a natural world setting.

Embedded systems. A strong education and training on the principles of embedded software, the many principles of programming, algorithms, software design, formal methods, and platforms (architectures and operating systems) are necessary to enable the development of reliable and high-quality cyber components of a CPS system.

Physical properties. It is important to understand and be able to model the physical properties of the environments and hardware platforms. Software design principles that address the realisms of the physical world in such a way as to satisfy safety, reliability, real-time performance, risk management, and security requirements need to be part of the curriculum.

Human interaction. Human factors design, human-in-the-loop control, and understanding and accounting for the behavioral responses of humans are important for many CPS. One important design issue is making CPS easy for humans to operate, control, and maintain. Similar to other engineering disciplines, hands-on projects and interdisciplinary teamwork are also fundamental to understanding and seeing core principles applied.

5.BASICS OF INDUSTRIAL IOT:

Industrial Internet of Things (IIoT)

IIoT is the use of those connected technologies to enhance manufacturing and industrial processes. It utilizes software, sensors, data systems, and more in manufacturing to improve speed, efficiency, and business performance.

The worldwide market for the IoT was $16.3 billion in 2016 but is expected to reach $185.9 billion by 2023, illustrating the relevancy of IoT for all industries during the coming years and decades.

MachineDesign.com, a technical resource created primarily for mechanical engineers, offers some examples of common IIoT use cases available today:

MachineDesign.com, a technical resource created primarily for mechanical engineers, offers some examples of common IIoT use cases available today:

- **Preventive maintenance**: Records and communicates run-times or equipment cycles to avoid or predict asset downtime before it happens.
- **Predictive maintenance**: Provides warnings for conditions that indicate impending failure.
- **Energy consumption monitoring**: Provides power-consumption rates and assists in decisions to adjust equipment power usage to avoid peak-use energy penalties.
- **In-line quality sensors**: Delivers real-time data to the quality-assurance department to reduce labor for regulatory sampling, allowing for quick reaction to quality issues with raw materials or finished products.
- **Batch optimization**: Gives process engineers batch data and trends to optimize product production, "including improvements to mixing, heating, and cleaning times."
- **Proportional-integral-derivative (PID) loop tuning**:Time-series process data used for "PID loop-tuning improvements, mechanical performance issues of control valves, or finding root causes of process variations."
- **Inventory planning assistance**: Offers real-time inventory information, which can improve scheduling, shipping, and raw materials and finished goods ordering.

5. Write briefly about Industrial sensing and actuations.

1.7 INDUSTRIAL SENSING AND ACTUATION

The Internet of Things is a major contributing factor to the new Data Economy. The value of an IoT system goes beyond the originally intended use case, for instance in automation. This is because the further value lies in the intelligence that an IoT system creates. Sensors are the source of IoT data and sensors and actuators in IoT can work together to enable automation at an industrial scale. Finally, analysis of the data that these sensors and actuators produce can provide valuable business insights over time.

What are the main sensors and actuators?

Sensors and actuators often work in tandem, but they are essentially opposite devices. A sensor monitors conditions and signals when changes occur. An actuator receives a signal and performs an action, often in the form of movement in a mechanical machine. Another key difference is their location within the system.

Driven by new innovations in materials and nanotechnology, sensor technology is developing at a never-before-seen pace, resulting in increased accuracy, decreased size and cost, and the ability to measure or detect things that weren't previously possible. In fact, sensing technology is advancing so rapidly that we will see a trillion new sensors deployed annually within a few years.

Sensors

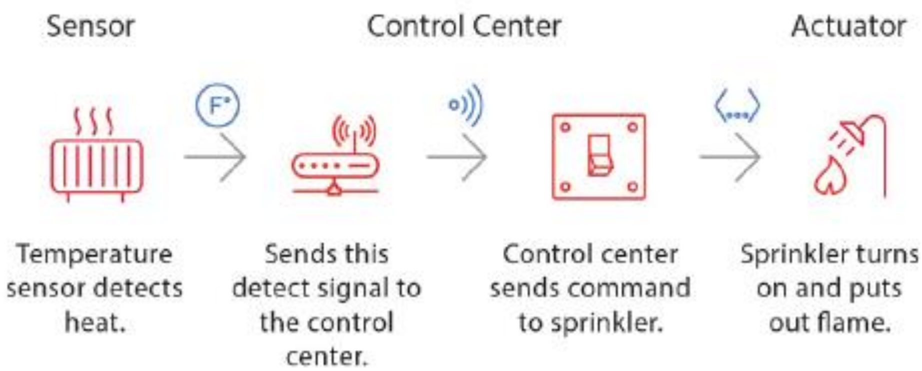
A better term for a sensor is a transducer. A transducer is any physical device that converts one form of energy into another. So, in the case of a sensor, the transducer converts some physical phenomenon into an electrical impulse that determines the reading. A microphone is a sensor that takes vibrational energy (sound waves) and converts it to electrical energy in a useful way for other components in the system to correlate back to the original sound.

Actuators

Another type of transducer that you will encounter in many IoT systems is an actuator. In simple terms, an actuator operates in the reverse direction of a sensor. It takes an electrical input and turns it into physical action. For instance, an electric motor, a hydraulic system, and a pneumatic system are all different types of actuators.

Controller

In a typical IoT system, a sensor may collect information and route it to a control center. There, previously defined logic dictates the decision. As a result, a corresponding command controls an actuator in response to that sensed input. Thus, sensors and actuators in IoT work together from opposite ends.



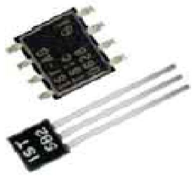
Types of Sensors Used in Industrial Automation

Temperature Sensors :

A temperature sensor is a device that collects information concerning the temperature from a resource and changes it to a form that can be understood by another device. These are commonly used category of sensors which detect Temperature or Heat and it also measures the temperature of a medium.

Digital Temperature Sensors and Humidity & Temperature Sensors are few of the main temperature sensors used in automation.

Digital Temperature Sensors:



These Digital Temperature Sensors are silicon-based temperature- sensing ICs that provide accurate output through digital representations of the temperatures they are measuring. This simplifies the control system's design, compared to approaches that involve external signal conditioning and an analog-to digital converter (ADC).

Humidity & Temperature Sensors

The Temperature & Humidity sensors attribute a temperature & humidity sensor complex with a measured digital signal output. By utilizing the technique and temperature & limited digital-signal-acquisition humidity sensing technology, it ensures high consistency and exceptional long-standing stability.

Applications of Temperature Sensors:

- They are weatherproof & designed for continuous temperature measurement in air, soil, or water
- Exceptional accuracy and stability
- For measurements in complex industrial applications
- For measurements under rough operating conditions

Pressure Sensors:

The Pressure Sensor is an Instrument that apprehends pressure and changes it into an electric signal where the quantity depends upon the pressure applied.

Turned parts for Pressure Sensors and Vaccum Sensors are few of the major pressure sensors used in Industrial automation.

Turned parts for Pressure Sensors

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These Pressure sensors are widely used in Industrial and hydraulic systems, these are high pressure industrial automation sensors also used in climate control systems.

- **Vaccum Sensors**

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Vaccum Sensors are used when the Vaccum pressure is below atmospheric pressure levels and it can be difficult to sense through mechanical methods. These sensors generally depend on a heated wire with electrical resistance correlating to temperature. When vaccum pressure increases, convection falls down and wire temperature up rises. Electrical resistance increases proportionally and is calibrated adjacent to pressure in order to give an effective measurement of the vaccum.