INTELLIGENT INSTRUMENTATION ASSIGNMENT

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Explain the biological and artificial model of Neuron.

Module 7

Neural Networks are parallel computing devices, which is basically an attempt to make a computer model of the brain. The main objective is to develop a system <u>to perform various computational tasks faster than the traditional systems</u>. These tasks include pattern recognition and classification, approximation, optimization, and data clustering.

Artificial Neuron:

Artificial Neural Network (ANN) is an **efficient computing system whose central theme is borrowed from the analogy of biological neural** networks. The artificial neuron receives one or more inputs and sums them to produce an output.

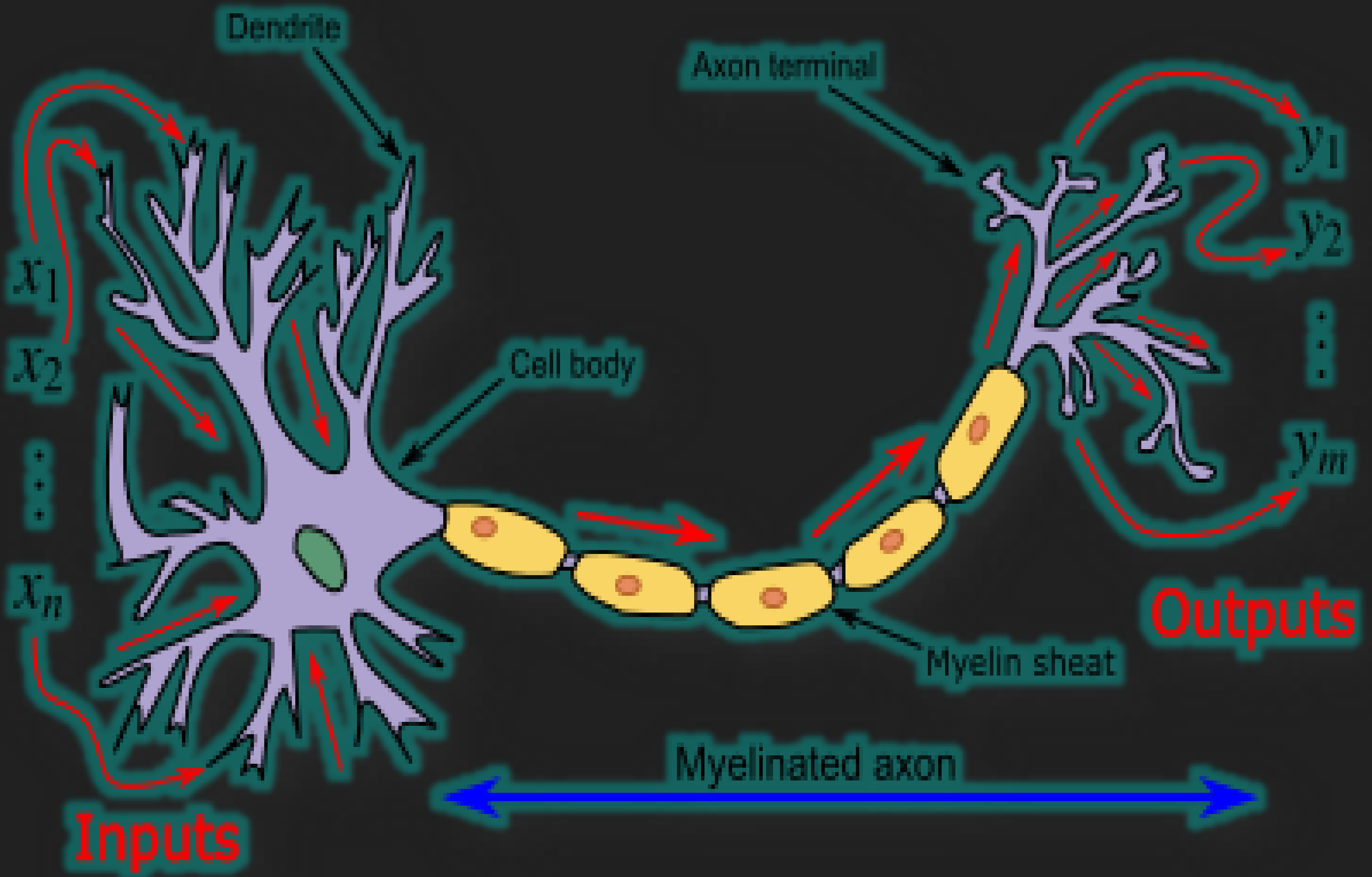
Biological Neuron:

A nerve cell neuron is **a special biological cell that processes information**. According to estimation, there are huge numbers of neurons, approximately 10 ^ 11 with numerous interconnections, approximately 10 ^ 15.

A typical **biological** neuron consists of the following four parts –

- **Dendrites** – They are tree-like branches, responsible for receiving the information from other neurons it is connected to. In other sense, we can say that they are like the ears of neuron.

- **Soma** – It is the cell body of the neuron and is responsible for processing of information, they have received from dendrites.



- **Axon** – It is just like a cable through which neurons send the information.

- **Synapses** – It is the connection between the axon and other neuron dendrites.

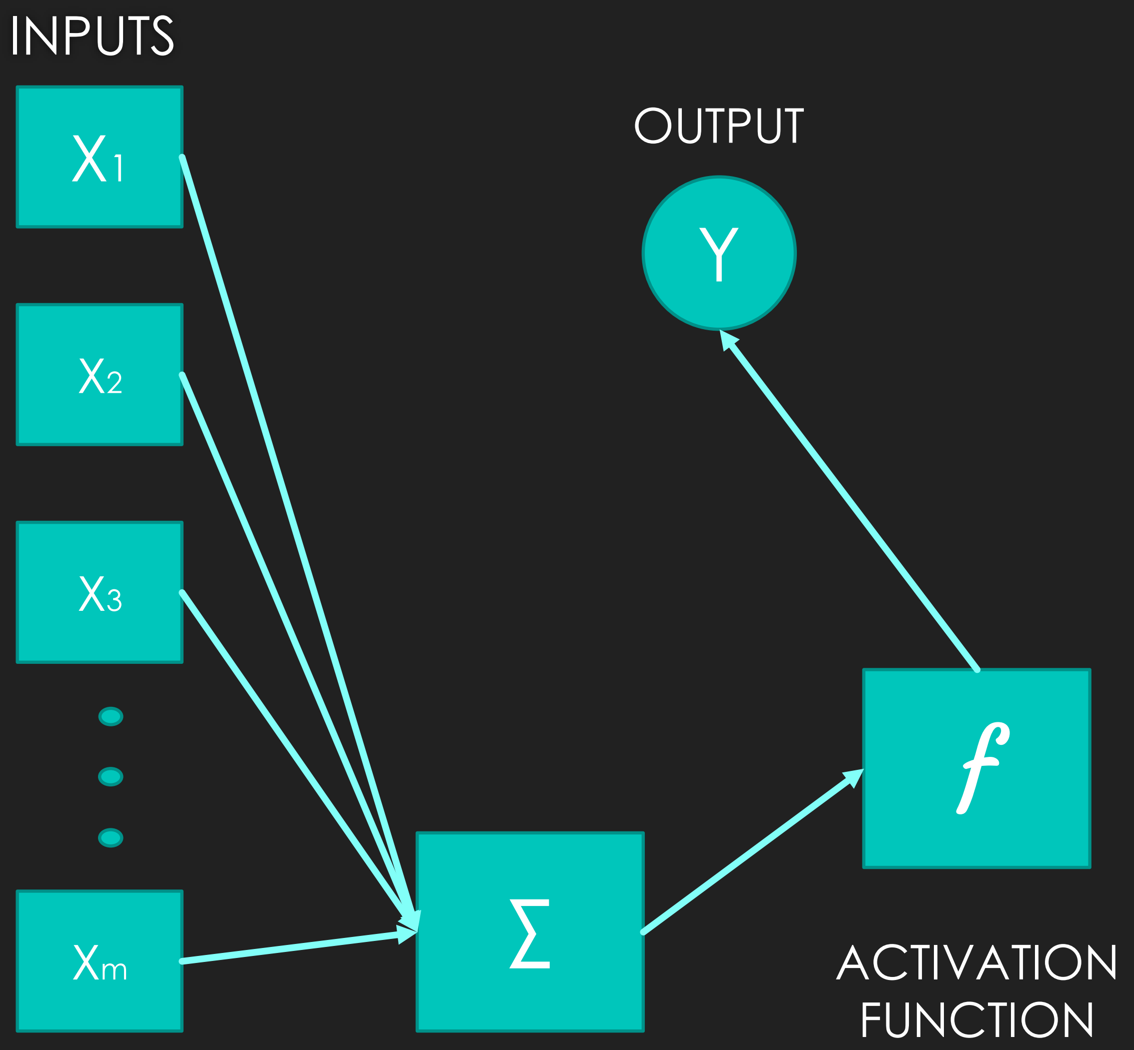
Every **artificial** neuron is connected with other neuron through a connection link. Each connection **link is associated with a weight** that has information about the input signal. This **is the most useful information** for neurons to solve a particular problem because the weight usually excites or inhibits the signal that is being communicated. Each neuron has an internal state, which is called an activation signal. Output signals, which are produced after combining the input signals and activation rule, may be sent to other units.

Net input:

$$Y_{in} = \sum m_i X_i \, . \, W_i Y_{in}$$

The output can be calculated by applying the activation function over the net input.

$$Y = F\,(Y_{in})$$



Comparison

Criteria	Artificial Neuron Network	Biological Neurons Network
Size	In order of 10 ^ 2 to 10 ^ 4 nodes.	10 ^ 11 neurons and 10 ^ 15 interconnections
Fault Tolerance	Robust Performance.	Performance degrades with even partial damage
Storage Capacity	Stores the information in continuous memory locations.	Stores the information in the synapse
Learning	Structured and formatted data is required to tolerate ambiguity .	They can tolerate ambiguity
Processing	Massively parallel, fast but inferior than BNN .	Massively parallel, slow but superior than ANN

Question: Explain the architecture of PLC and its Scan Cycle.

Module 6

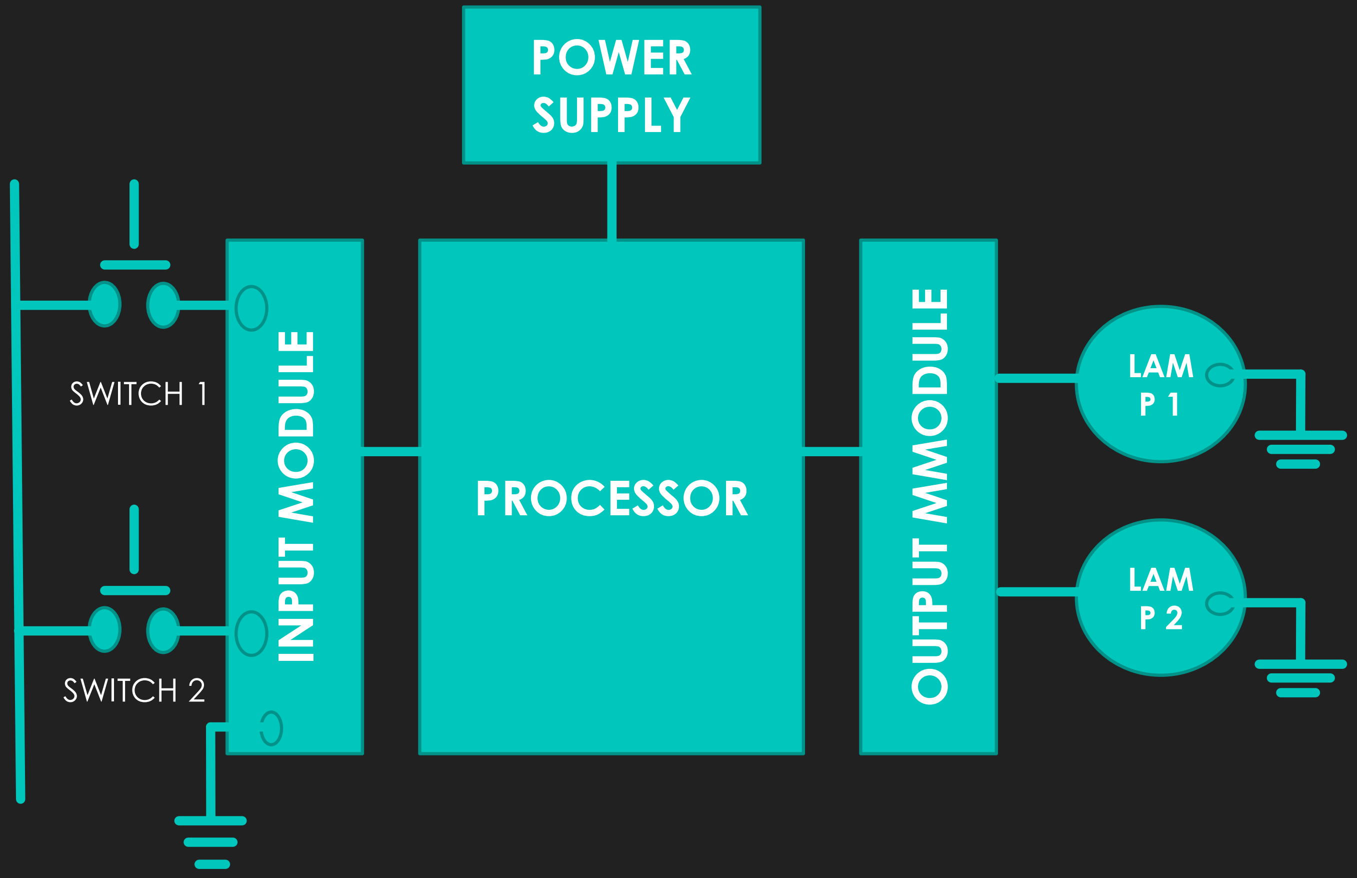
PLC stands for programmable logic controllers. They are basically **used to control automated systems** in industries. they are one of the <u>most advanced and simplest</u> forms of control systems which are now *replacing hard-wired logic relays* at a large scale.

Advantages:

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

PLC Architecture:

A basic PLC system consists of the following sections:



➢ Input/Output Modules:

The type of input modules used by a PLC depends on the type of input device. For example, some respond to digital inputs, which are either on or off while others respond to analog signals.

The PLC **input circuitry converts signals into logic signals that the CPU can use.** The CPU evaluates the status of inputs, outputs, and other variables as it executes a stored program. The CPU then sends signals to update the status of outputs.

Output modules convert control signals from the CPU into digital or analog values that can be used to control various output devices.

➢ Power Supply:

The Power Supply is a module located in the PLC system module rack. The DC power (voltage and current) **it provides power the other modules in the rack**, such as the CPU, Co-processor Modules, and I/O Modules.
The line power provided to the PLC system also powers the I/O Field Devices.

➢ Central Processing Unit (CPU):

The function of the CPU is to **store and run the PLC software programs**. It also interfaces with the Co-Processor Modules, the I/O Modules, the peripheral device, and runs diagnostics. It is essentially *the "brains" of the PLC*.
The CPU contains a microprocessor, memory, and interface adapters.

➢ Memory:

The memory is divided into two parts- **The data memory and the program memory**. The program information or the control logic is stored in the user memory or the program memory from where the CPU fetches the program instructions. The input and output signals and the timer and counter signals are stored in the input and output external image memory respectively.

➢ Peripheral Device:

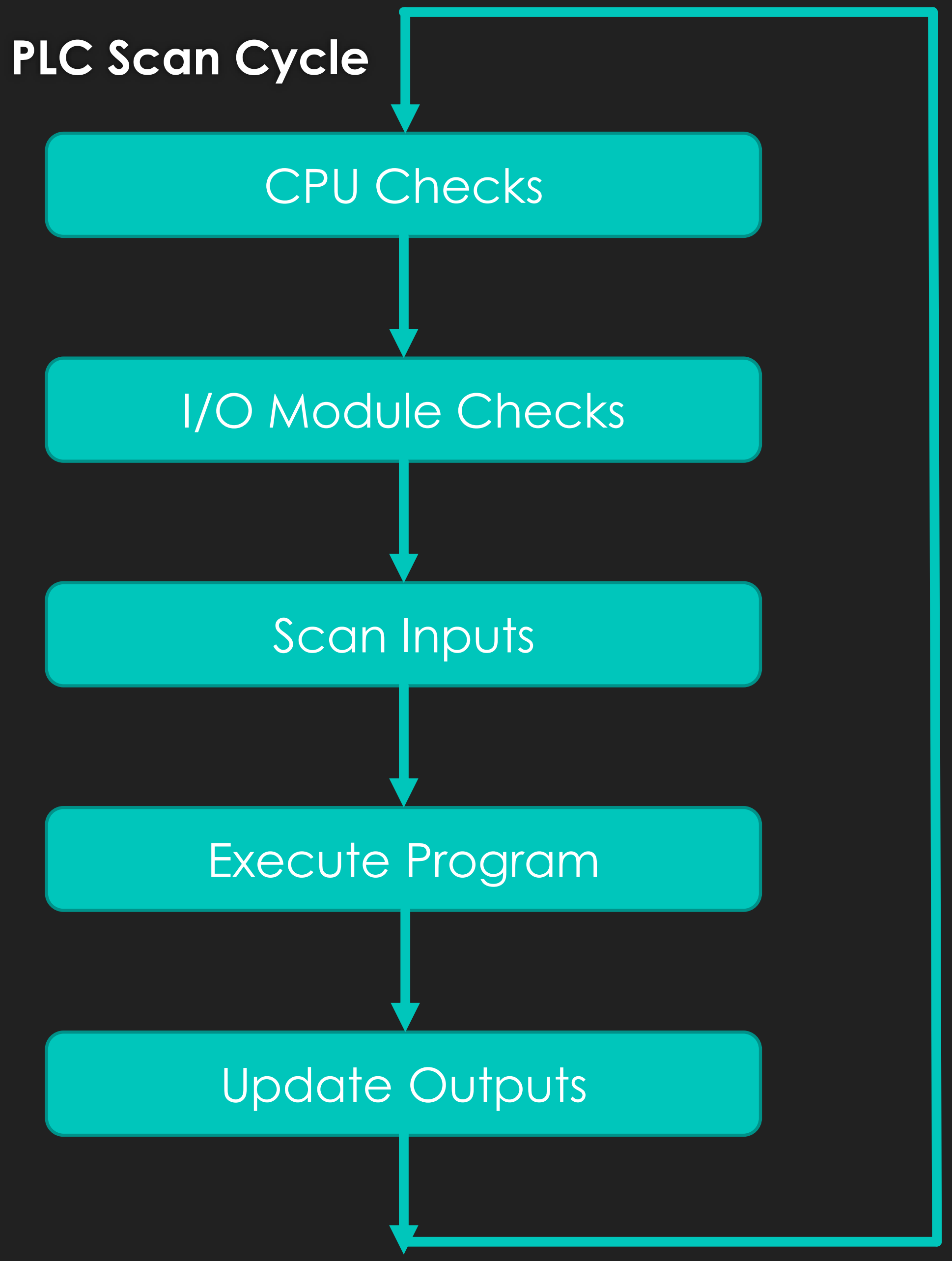
The function of the peripheral device is **to input data and monitor the equipment operation**. It may be a personal computer, handheld programmer, or an operator touch screen.

Basic Operation:

The operation of a PLC is very simple. The processor makes decisions based on a ladder logic program written by the user. In order to use the program properly, the PLC must **communicate with the various field devices it is tasked with monitoring and controlling**. It then compares the actual conditions of the field devices with what the program instructs them to do, and **updates the output devices accordingly**.

The Scan Cycle:

PLCs operate by continually scanning programs and repeat this process many times per second. When a PLC starts, **it runs checks on the hardware and software for faults, also called a self-test**. If there are no problems, then the PLC will start the scan cycle.



The scan cycle consists of three steps:

- **Input Scan**:
  A simple way of looking at this is the PLC takes a snapshot of the inputs and solves the logic. The **PLC looks at each input card to determine if it is on or off and saves this information in a data table for use in the next step**. This makes the process faster and avoids cases where an input changes from the start to the end of the program.

- **Execute Program (or Logic Execution)**:
  The PLC executes a program **one instruction at a time using** only the memory copy of the inputs the ladder logic program. For example, the program has the first input as on, since the PLC knows which inputs are on/off from the previous step it will be able to decide whether the first output should be turned on.

- **Output Scan**: When **the ladder scan completes, the outputs are updated using the temporary values in memory**. The PLC updates the status of the outputs based on which inputs were on during the first step and the results of executing a program during the second step. The PLC now restarts the process by starting a self-check for faults.

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