Computer Integrated Manufacturing
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Lecture 33
Programming Logical Controller

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The next topic of discussion is going to be program logic control. Where does this program logic control comes in a big way? In all automation systems, all CNC systems, rapid prototyping systems, inspection systems, you will have a program logic controller. In the MCU part, whatever we were seeing, DLU or we were looking at that digital input. Then we were talking about control data.

So, in that control data part, we will have a lot of involvement of program logic controller, which is otherwise called as PLC. When the automation was done in hard way by using CAMs and by using Geneva mechanisms by using stoppers, so we were doing it everything on hard. Then the next advancement came a little bit of soft. In this soft, we have this program logic controller. So here, you will write a program, which is basically logic based, and then you will fit it into your controller and execute the operation. That is why the program logic controller is also called a 'brain of automation system'.

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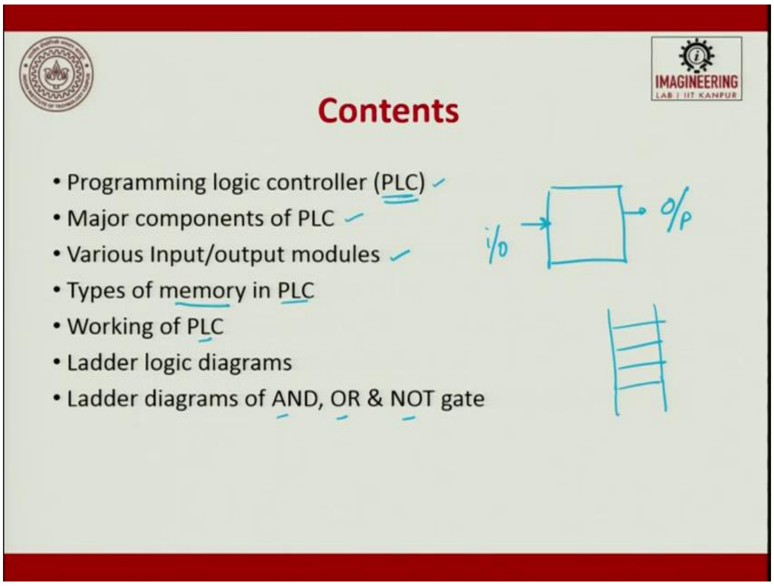

In the content today, we will see the programming logic controller, PLC. What is PLC? What are all the major components of PLC? Is it a single box or is there anything inside the box. Those things are called as the major components of PLC. Various input/output modules. When you talk about a box, so the box should have an input and it should have an output.

So, what are all the input/output modules, which are there for a PLC? Then, today PLC is also called as a computer, so now we also talk about different types of memories in PLC. Next, we will see very primitive how is the working of PLC happening? At the last, we will see what are the programming software? Which is used which is nothing but a ladder logic diagram? Ladder logic diagram will be used. Ladder means what? A ladder is something like this.

So, we will try to have logics built in this ladder. So, that is what is a ladder logic diagram. Then, we will see some examples like using AND command, OR command, and NOT gates in the logic. This is only an introductory lecture of PLC. There is a big ocean of knowledge behind this PLC that I leave it to the participants to acquire as and when it is needed. So, we will see only the primitive part and without PLC, you cannot run a flexible manufacturing system. You cannot run a Sims environment to a large extent.

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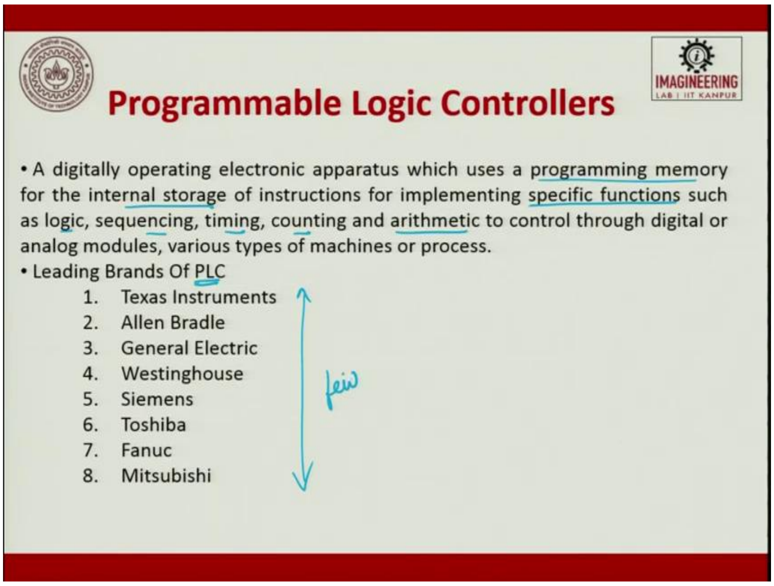

What is a programmable logic controller, PLC? A digitally operating electronic apparatus which uses a programming memory for the internal storage of instructions for implementing specific functions such as logic, sequence, timing, counting and arithmetic to control through digital or analog modules, various types of machine or processes.

So, you can see here, it will—it talking about programmable memory, internal storage. So, why internal storage? When you write a program if it is internally stored, you can call the program and start executing it and when you start doing it, it is like a library function, what is available in your software for a specific function.

This specific function can be on/off, can be counting, can be clocking the memory, for example, when we try to do in a microwave oven, so what do we do? We set the timer or in a bread toaster, we set the timer. It is spring-loaded. So, it unwinds, and once it comes to standstill (0, 0). It tries to disconnect the connectivity between live wire and the instrument. So here, it is spring load. You can also convert this spring load into a timer. So, logic sequencing timer. For example, sequencing is also very important as and when one activity is over, there will be a set of logics.

Let us take a simple example of your bathroom flush, whatever we use. As and when the water gets drained, the first sequence of the operation will be there has to be an in-water getting filled into the tank, and simultaneously, the ball, which is floating, or to indicate the level will also start moving up and up and up. The moment the water tank is full, the input is shut. How is it shut? It is shut because the ball, which floats, is connected to a lever, that lever, in a term, closes it and when we operate a flush, we just operate the button and the water gets drained and the float starts sinking down.

Here you see, there is a sequence of operation. So, the sequence has to be maintained one after the other. In a flush, it is all a mechanical system. But, in reality, in a CNC machine, there are several things, which are electronically controlled. So, this electronically controlled also has to be established in a sequential fashion, one after the other. So, that is what is sequencing.

Then, next is timing. So, you do an operation and wait. For example, all the process industries look for timing control. When we talk about the packaging industry, they talk about counting. When I recently visited a biscuit manufacturing company, the biscuits are produced in thousands and from there it has to be sorted to five and once five biscuits come, it has to be packed.

So, now counting of the five biscuits then establishing a sequence of paper wrapping around it. So, counting is one thing, which is used in PLC, and we can also arithmetic to control. For example, AND logic, OR logic, or NOT logic to control through the digital and analogs module. The various types of machines and machining processes used, it is exhaust PLC finds its major application in the process industry as well as in the CNC industry.

The leading brands of PLC are Texas Instruments, they have one, Allen Bradley, then General Electric, Westinghouse, Siemens, Toshiba, Fanuc, Mitsubishi. All these are leading brands of PLC which are used and this PLC you will not be able to see from outside. It will be kept inside a box and that box will control the entire machine. So, these are all some of the leading and here I have just put 1, 2, 3, 4 it does not mean the ranking of them.

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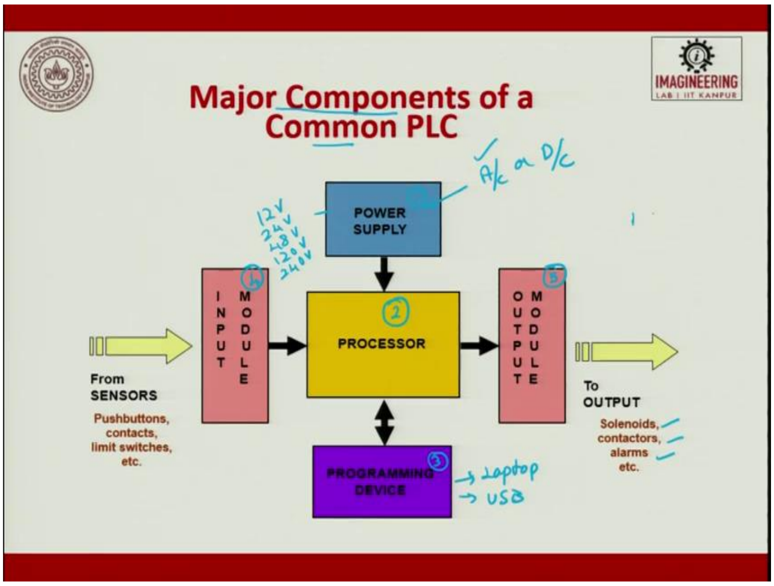

When we talk about the major components of a PLC, you will have a power supply. This power supply can be AC or DC. Generally, today what we do is we try to use only AC power supply because DC conversion—that is a huge amount of losses. So, we will use an AC power supply for it and here you will operate it from 12 volts, 24 volts, 48 volts, 120 volts, and 240 volts.

So, you can choose depending upon the power supply you can choose the rating. Then this power supply is attached to your processor. Your processor will host the program. So, your processor will establish the sequence of operations. So, whether it is following the sequence and in the sequence, what is to be done will be done.

So, for this processor, to follow your sequence, we use a program. So, there is a programming device, which is fitted on to the processor. This can be a laptop or it can be a standalone USB port, you write a program and plug it in, the processor starts working, so this is a programming device. So, you will have input and output devices. Input device, if you see, are from different types of sensors. For example, presence, absence, pushbuttons, contact switch, limit switch, etc. etc.

The output will be activating a solenoid, activating a drive system, raising an alarm and then also trying to establish some contacts between the system, these are all the possible outputs. So, if we ask what are the major components? One is a power supply, two is the processor, three is the programming, four is the input module and five is the output module.

So, the PLC will be attached in a CNC machine, PLC will be attached to the drives. For example, switching on a motor, switching off a motor, all the miscellaneous commands whatever we use will be actuated by this output module.

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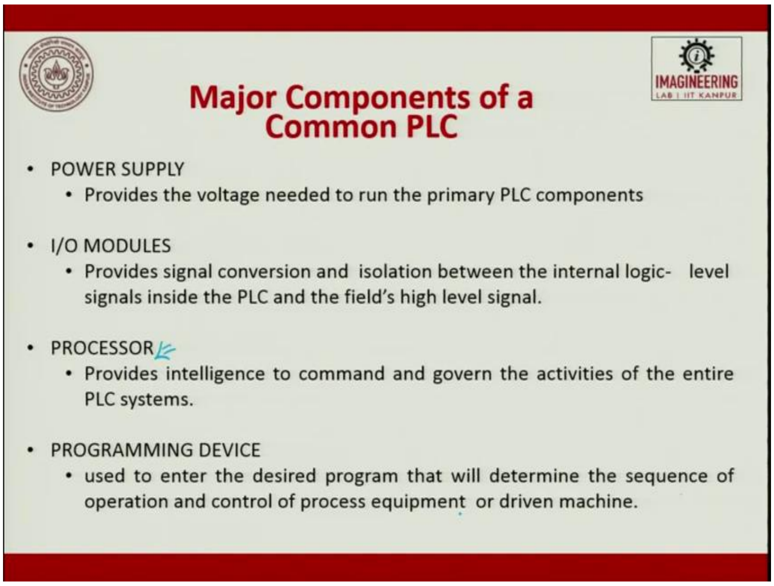

The power supply provides the voltage needed to run the primary PLC components. Input/output modules provide the signals, conversations, and isolation between the internal logic level signal inside the PLC and the field's high-level signals. So, input/output devices are basically for in and out. The processor; provides intelligence to command and govern the activity of the entire PLC system is done by a processor.

Like a computer, we have a processor, in PLC also, we have a processor. Programming device-used to enter the desired program that will determine the sequence of operation and control of process equipment or driven machines.

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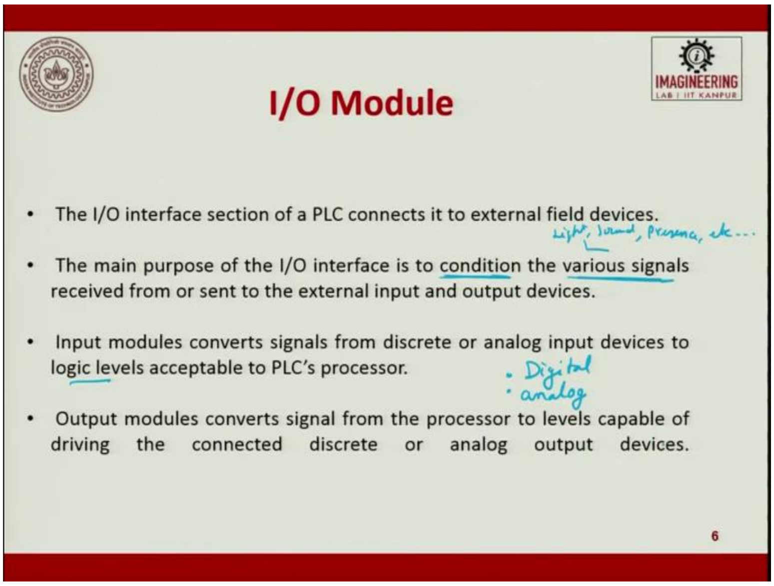

The input/output interface section of a PLC connects it to the external field devices. The external field devices are sensors, limit switches etc. The main purpose of the input/output interface is to condition the various signals received from or sent to the external input and output devices. Conditioning, conditioning of various signals. Various signals can be light-based, can be sound-based, can be presence-absence, etc.

The input module converts signals from discrete or analog input devices to a logic level acceptable to PLC's processor. So, as I told you in the CNC itself, you will have a digital signal and you will have an analog signal depending upon the digital or analog output. So, you will try to set a logic level and try to get. So, the output modules convert signal from the processor or to levels capable of driving the connected discrete or analogous output devices.

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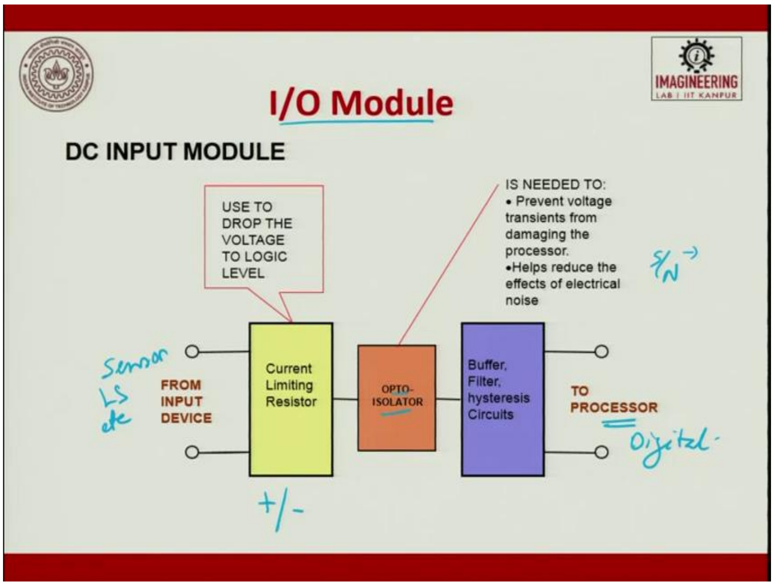

So, the DC input module, we are discussing about DC. Today, you also have AC. So, these are input. So, the current limiting resistor used to drop the voltage to logic level. So, we use here current limiting resistor. Then we have an optoisolator, is needed to prevent voltage transients from damaging the processor we have here optoisolator that helps to reduce the effect of electric noise.

So here, you have to have a perfectly controlled noise, you should not have any noise along with the signal. So, once it is there if the noise and the signal are not so, the S by N ratio is not so great, so then, what will happen? The PLC immediately activates or deactivates the sensor and you might lead to malfunctioning. So we have to make sure that the conditioning of the signal, which comes into the processor is of control.

This helps reduce the effect of electrical noise, which is done by the optoisolator. Then finally, it goes to buffer, filter, hysteresis circuit. So, these are from the input devices which are nothing but sensors, limit switches, etc, So here, it goes to the processor because it gets the signal from here, and the signal converts into yes/no level because PLC works on digital. So, here you have only two levels, yes or no. So that has to be regulated. So, use to drop the voltage to logic level. So maybe if you get 12 volts, we will try to step it down to 5 volts such that the processor can stop working with the signal.

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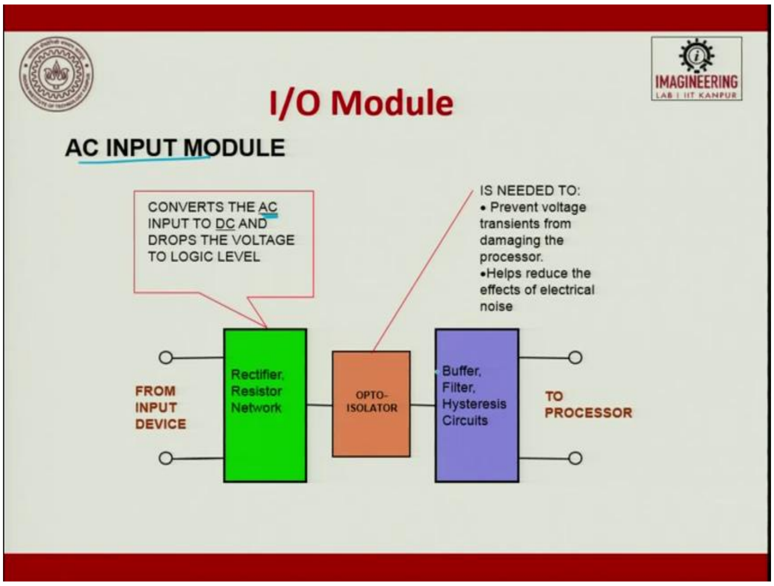

AC input module, an AC input module, you have a rectifier resistor network. So, the rectifiers function is to convert the AC input to the DC signal and drop the voltage to the logic level. So here, we did not have that, we had only resistor network but here you will have a convertor with us. Then you will have an optoisolator, the same function what it does and then you will have a buffer, filter, hysteresis circuit, etc.

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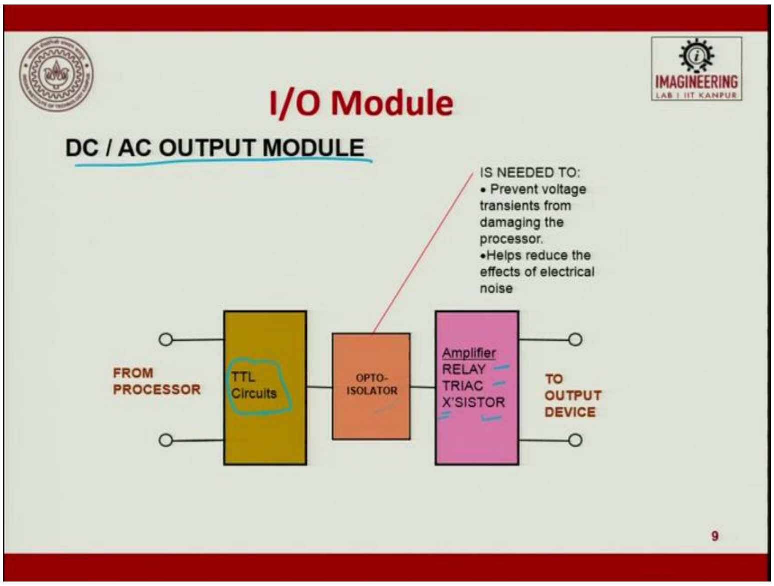

So, AC/DC output devices, we saw two input devices, now we will see AC/DC output devices. So here, from the processor, we will try to take a TTL signal and then send it to an optoisolator. TTL signal is a transient logic. So here, we will try to see whether it is plus five, minus five.

Then we put an optoisolator, so it prevents voltage transients from damaging the processor. So, it also helps to reduce the effect of electrical noise, the same function and then we try to attach it to an amplifier, relay, triac or a transistor or a X-sistor is done and it tries to amplify and then give it to the output because the output needs higher voltage signals.

So, we have to amplify. So first, we have to regulate it, bring it to the lower level, the processor works and then we have to jack it back and it is sent to the real applications.

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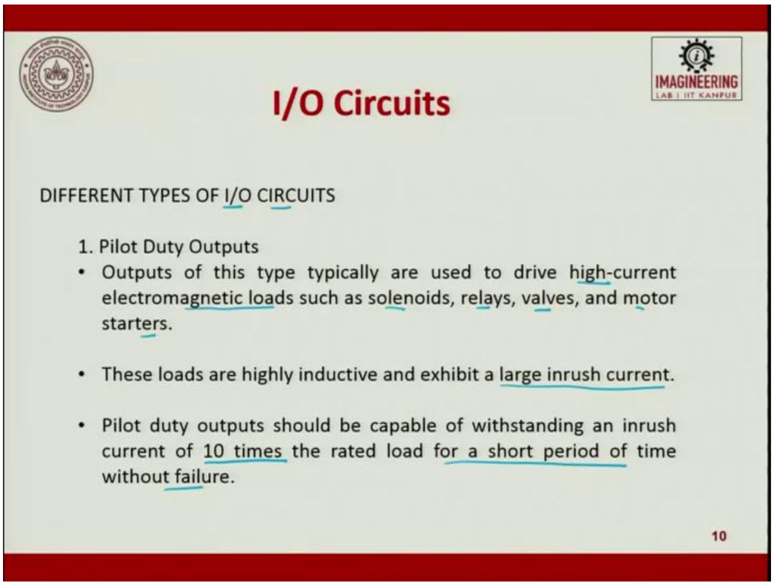

The different types of I/O circuits. Pilot duty output, the outputs of this type typically are used to drive high-current electromagnetic loads such as solenoids, relays, valves, and motor starters. So, what is a solenoid? The on-off switch is a solenoid. Valves open-close, motor start-stop we have a motor starter circuit today, so, where need a very high current. So, pilot duty output is where the output of this type typically uses to drive a high current electromagnetic load.

These loads are highly inductive and exhibits a large inrush current, sudden current. Pilot duty outputs should be capable of withstanding an inrush current of 10 times the rated load for a short period of time without failure. See the surge in current, so the surge in current should be so high, such that it is used to start a starting torque, a very high torque it starts, and then it just regulates. The starting torque, if you do it mechanically, you need to apply so much of force but in an electrical circuit, starting torque is taken by the current. So we give a very high current.

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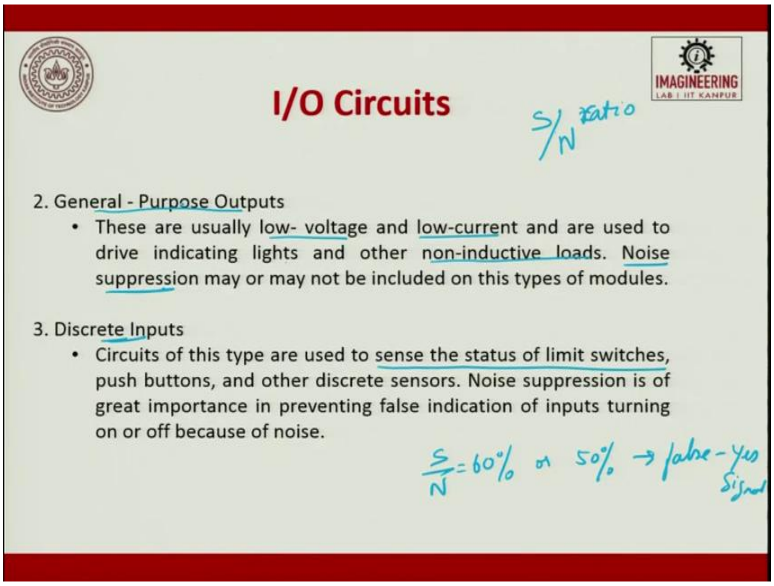

So, general-purpose output. These are usually low voltage, low current which is used inside a CNC machine automation system low voltage, low current, and are used to drive indicating lights and other non-inductive loads. For example, today you have a smartphone. Through a smartphone, you are able to control the intensity of the lights, switching on of the lights, switching on of the AC, all these things.

All these things can happen provided you have a proper general-purpose output circuit available. Noise suppressors may or may not be included in this type of the module. Noise suppressors, so that is what I said when you start working on all these low signal voltages, it is S by N ratio very important. N should be as small as possible S should be as large as possible. So, we are now a days working on reducing the N such that you get a proper S so it can be on and off.

Discrete input. The circuit of this type is used to sense the status of limit switches, pushbuttons and other discrete sensors. Circuits of these types are used to sense the status of limit switches, pushbuttons, and other discrete sensors. So, it is yes-no. Noise suppressors is of greater importance in preventing false indications of input turning on and off because of the noise.

So, this is what I said. If the S by N ratio is close to 60% or 50%, then you will get a false yes signal. Yes, signal or a no signal, false, which is not correct. So that is what we are talking about. Discrete input, general-purpose output and we talked about pilot duty outputs.

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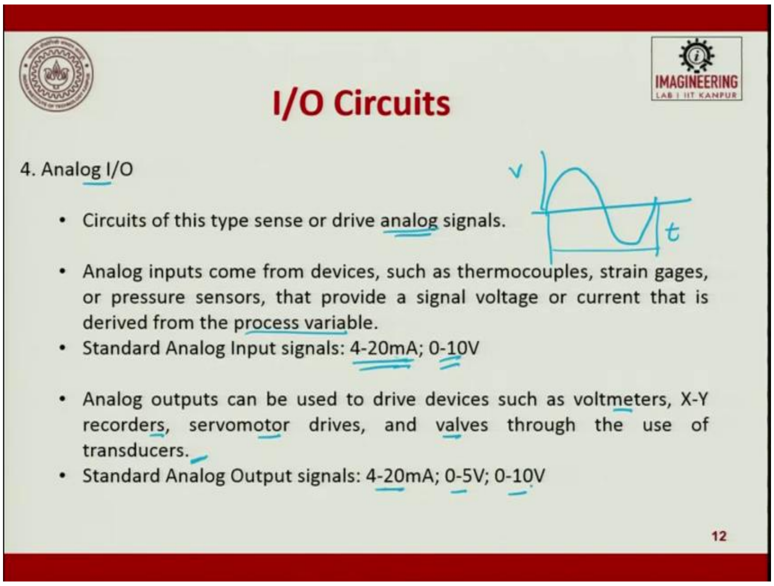

There is a need today to work on analogous input/output also. The first three what we saw was discrete. Now, we are trying to see the analog input/output. The circuit of this type sense or drive analog signals. Analog signal or continuous signal because for a period of time, I would like to discretize to my requirement. So in that way, I would like to play with the analogous signal.

So the circuit of these types sense or drive analogous signal. Analogous inputs come from devices such as a thermocouple, strain gauge, or pressure sensors that provide a signal voltage or current that is derived from the process variable. So, the analogous work in a typical range of 4 to 20 mA, please note, it is milliamps. When we talk about high current, it is all in amps.

Here, we are talking about milliamps. The operating voltage is 0 to 10. The analog outputs can be used to drive devices such as voltmeters, X-Y plotters, servomotor drives, and valves through the use of transducers. Simple example of bathroom closet, we gave, so that works on level sensor and then opening and closing of the valves, transducers. The standard analogous output signals will be 4 to 20 millivolts, so inputs is 4 to 20, the output will also be 4 to 20. The output can be 0 to 5 or 0 to 10 volts, which in turn, goes and activates your drive.

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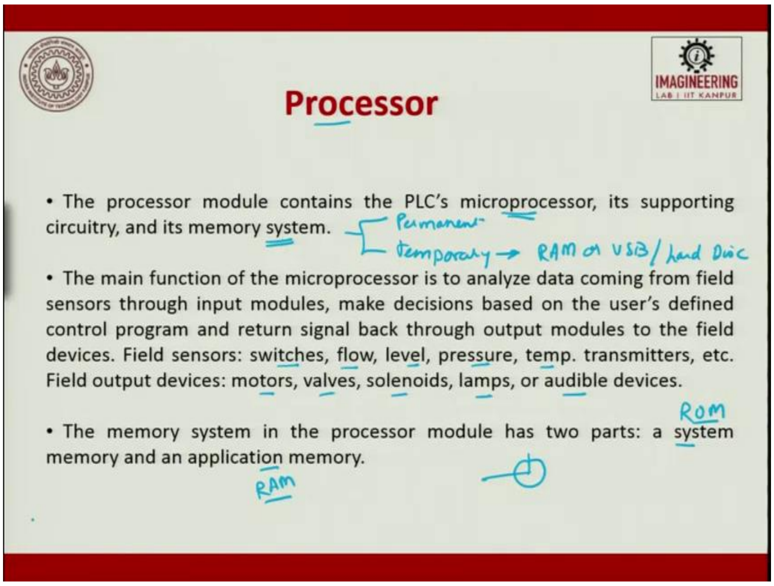

Next, we will see about the processor. The processor module contains the PLC microprocessor, its supporting circuitry, and its memory system. So, your processor will also have a memory system. Memory you can have permanent and temporary. So temporary you can have through your RAM space or you can use it through USB or a hard disk. Possible, right?

So the memory system is also a part of the PLC processor. So PLC, microprocessor, its supporting circuitry, and the supporting circuitry are the interfaces with the input and output and other things. And then, you will also have a memory system. The main function of the microprocessor is to analyze data coming from the field sensors through the input module, make decisions based on the user's defined control program and return signal back through output modules to the field device.

The field sensors can be switches, flow, level indicator, pressure, temperature transmitters, etc. The output devices can be motors, valves, solenoids, lamps, and audible devices. So all these things are output devices and sensors field sensors are going to be switches, flow indicator, level indicator. Flow is nothing but the discharge Q. Level indicator is the level against the linear scale it compares and nowadays it may not compare it with the linear scale, it in turn is controlled by a rotary motion.

So, where the lever moves up and down, it is controlled on a circular or rotary rather than a linear scale. They are reducing the size of a sensor. Then for pressure, temperature transmitters. The memory system in the processor module has two parts: a system memory and an application memory. System memory is your ROM space and application memory is something like your RAM space. Please try to understand I am giving only analogy, please do not take it in one to one sense. System memory and an application memory, two memories are there.

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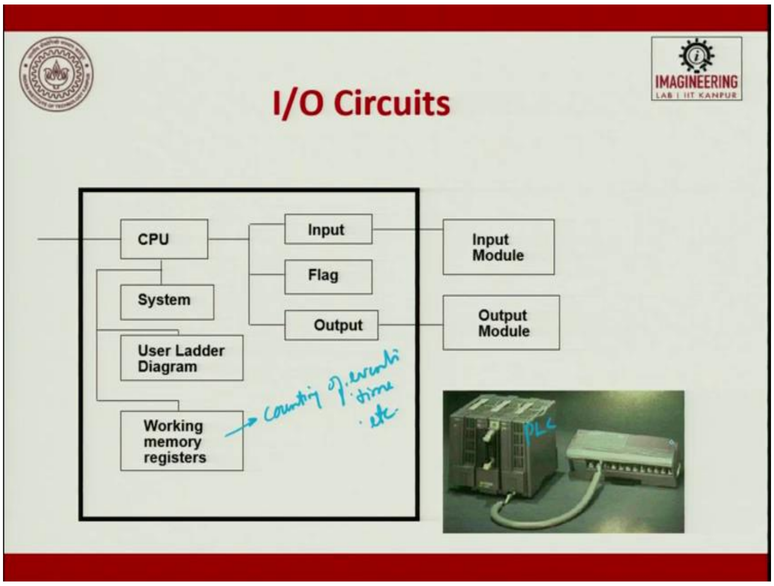

So, the input/output circuit, if you see, a CPU will be there, a system will be there. You will have a user ladder diagram will be there. Then there will be a working memory space. Working memory is used for counting of events, time and etc. So that is the working memory registers. So, whatever gets from the ladder diagram, so if there is a flow of one data signal so that will go get recorded and here and it keeps on adding.

So, from a CPU you will have input, you have flags and you have output. Input is attached to the input module, the output is attached to the output module and a flag is a place wherein between these two, certain operations happen. So this is how it looks like. This is a PLC, which you see; these are the memory, which is attached.

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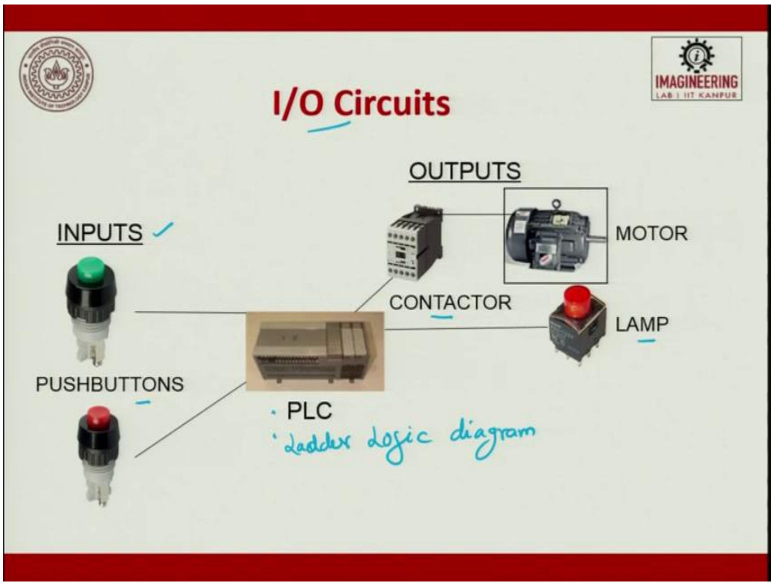

So, when you talk about input/output, so input device is a button. This is a push-button. This is a toggle switch, something like that. So input signals, you will have a PLC then PLC in turn connected to the contractor which in turn, starts a motor or it drives to switch on your bulb. So these are the inputs, all the processing information is done in the PLC, which follows a ladder logic diagram.

This is a programming language so which is used all these things happen here and when it says yes, the contactor is on. So this contactor, in turn, switches on the motor. So, here you can also attach it to this is high current, this is software, medium current or of a low voltage.

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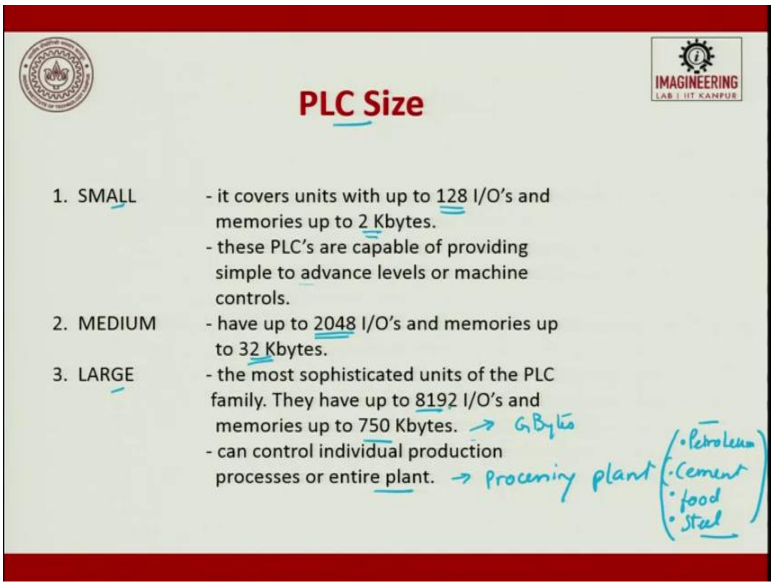

So, PLC size. There are three sizes of PLC. It covers units with up to 128 input/output and memories of up to 2 kilobytes. 128 inputs. So, in a CNC machine, we can have a small PLC size and used. These PLCs are capable of providing simple to advance levels of machine control, small. Medium, they have up to 2048 input/output devices and memories up to 32 kb. The large scale, the most sophisticated unit of the PLC family. They can go up to 8192 input/output devices, think of it as a robust machine.

So if you take any moving locomotive moving devices. For example, porcelain driller, a ground driller. So all these things have a lot of hydraulics with it. Apart from the normal locomotion, which is given by the engine, you have so many other hydraulic systems, which come. Almost in all the instinct, we will try to have a PLC, which tries to control. So the memory is going up to 750 Kb today the memories have gone even to gigabytes. It has gone to gigabytes. It can control the individual production process of the entire plant.

So this, we are talking about processing plant. Processing plant, you will have so many sensors. If you take a cement factory or if you take a steel mill if you take a food processing unit. So if they have steel, petroleum, all these things have a huge processing facility there. And here you will have a huge, a large PLC, which is, installed which can interact with 8192 input/output devices. Without PLC, you cannot have a CNC machine, which in turn can talk to a computer.

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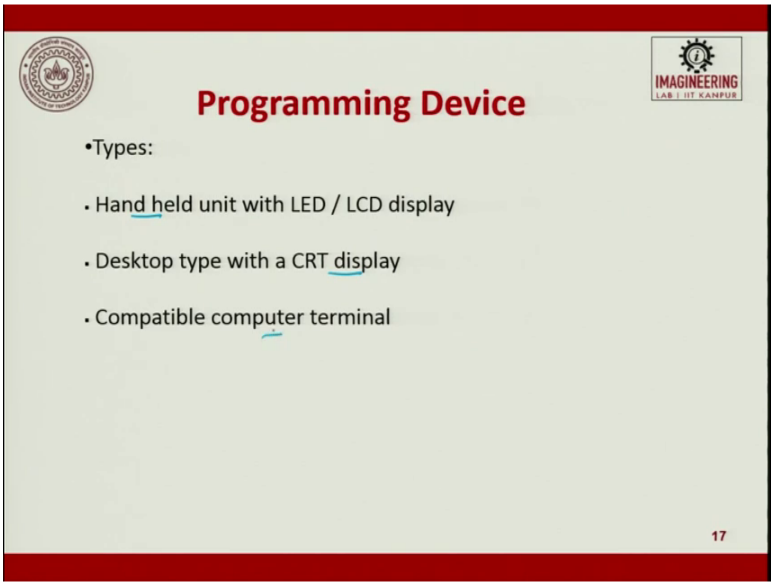

The programming devices, there are three types which is handheld like your manual entry in the CNC machine. You have a hand held units with LED/LCD display. You have a desktop type with a CRT display. Then you have a compatible computer terminal.

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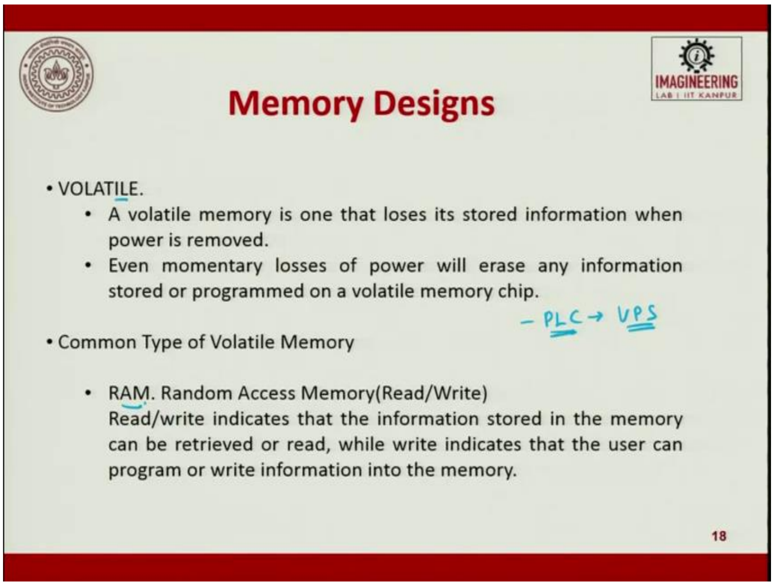

The memory devices are volatile. Volatile memory is one that loses its stored information when power is removed or when you press a reset button. Every momentary loss of power will erase any information stored and programmed on the volatile memory chip. So that is why, in PLC, you will also try to have a UPS attached to the machines so that it tries to give supply for some more time before it is getting shut off.

So, this is very important to avoid the volatility. Common types of volatile memory are RAM, which is random access memory. Read/write indicates that the information stored in the memory can be retrieved or read while write indicates the user can program or write information into the memory.

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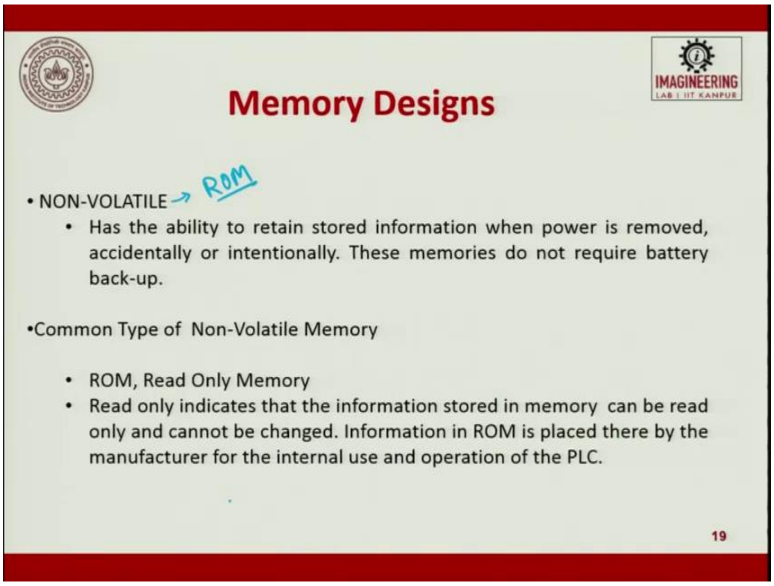

So, this read/write provision is given in the RAM. Non-volatile has the ability to retain stored information when the power is removed. This is your ROM space. So, this is generally basic function. Removed accidentally or intentionally, these memories do not require battery backup. The common types of non-volatile are ROM, read-only indicates the information stored in the memory can be read-only and cannot be changed. The information in ROM is placed there by the manufacturers for internal use and operations.

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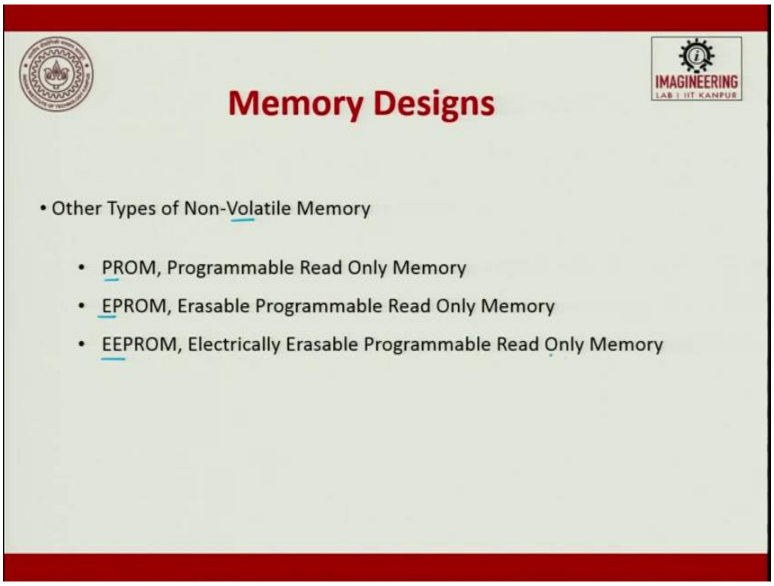

The other type of non-volatile PROM, EPROM, EEPROM. So, PROM is a programmable read-only memory. E is an erasable programmable read-only memory, like your computers.

EEPROM is electronically erasable. So you give a plus five volts, you give a minus five volts, whatever it is, you can try to remove all the programs. So, EEPROM is also available in the PLC.

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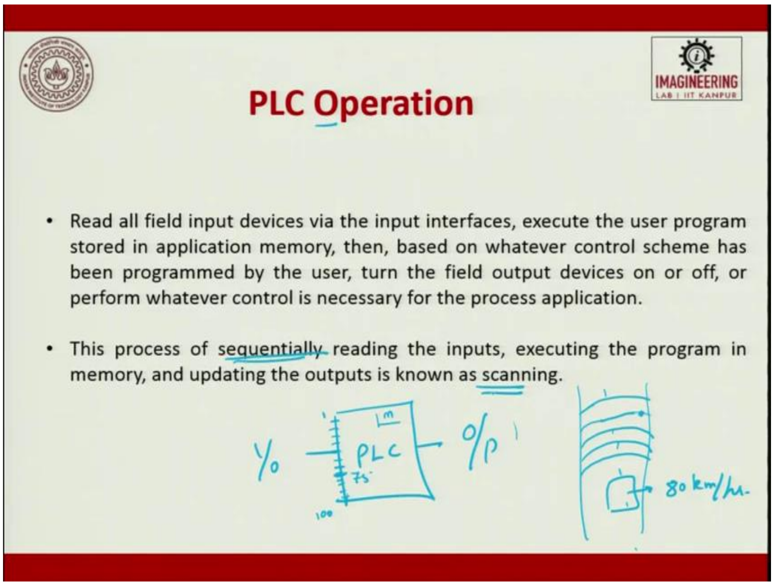

When we talk about the PLC operations, read all field input device via the input interface, executes the user program stored in the application memory, then based on whatever control scheme has been programmed by the user, turn the field output devices on or off, or perform whatever control is necessary for the process application.

So, what we are trying to say here is you have a PLC, you have input and you have output. So, an input signal is given. So, there is a program which executes it and after the execution is over, it tries to give an output signal. This process of sequentially reading the input executes the program in memory and updates the output is known as scanning.

Just an analogy, let us assume that you are going in a car and you are driving at 80 kmph. So, there is a clean road you keep going on the road. So every time what happens? By a large involuntarily eyes start scanning from this extreme end to this extreme end. So, it keeps on scanning like this and you keep doing it. Your scanning speed will be very high. So, you will quickly scan within a few microseconds or within a second from left extreme to the right extreme you will go. Assume that there is an object falling from the top at this point.

So, here what happens? Your previous canvas zone from here and then what you do is, you try to scan from the next port. So, when you try to scan it from the next point, you try to hit at this portion. Your scanning goes and then it will get out of this level. Suppose, when we are trying to scan at this portion if I erase and remove this object.

So, then next time your memory will assume that there is an object. It will slow down, gives little more thought for what is going on there, and then it will try to sweep. So, what is this? This is nothing but a sequential scanning. So that is what is told here. This process of sequentially reading the input.

So what I am trying to say, suppose you have 100 inputs here and you are somewhere close to the 75th input and let us assume 74th input has changed its status. This cannot go back and check the 74th status. It will come up to a hundred and then go back and scan from 1, come to 74 and then record the transient of the sensor data and record it. The process of sequentially reading the input, executing the program in memory.

So whatever is there in your memory is executed and you try to update this memory, the outputs, and then store it in memory, and then this, in turn, will be communicated to the output. So, this process is called scanning. So here, in PLC you should remember it is sequential scanning.

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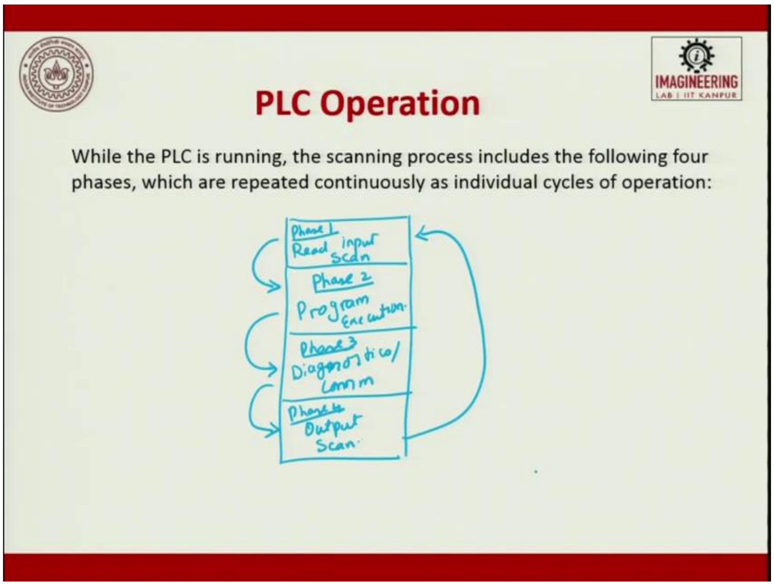

So, while PLC is running, the scanning process includes the following four phases. I will draw the phases, which are repeated continuously. As individual cycles of operations. So let us put four phases. S, phase one, it is ‘read input scan’. Phase two is ‘program execution’. Phase three is ‘diagnostic/communication’. Phase four will be an ‘output scan’. From the output scan, it goes here.

So now, from here to here, it goes, from here to here it goes, from here to here it goes. So, this is what is scanning what we are talking about. While the PLC is running, the scanning process includes the following four phases, reading, executing the program, recording, and then output activation. So which are repeated continuously as individual cycles of operation.

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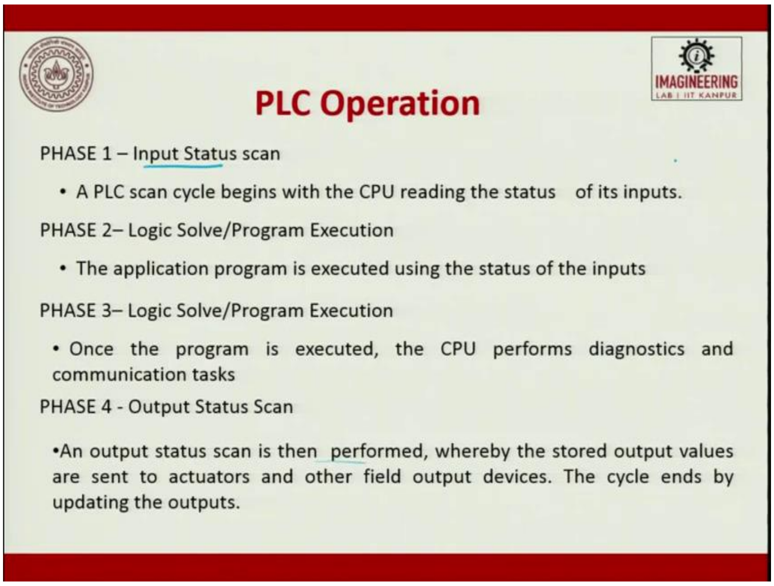

Phase one is the input status scan. A PLC scan cycle begins with the CPU reading the status of the input. Phase two, logical solve or program execution. The application program is executed using the status of the input. Then, phase three, logic solve, and program execution. Once the program is executed, the CPU performs diagnostics and communication tasks. Phase four is output status scan and output status scan is then performed, whereby the stored output values are sent to actuators and other fields of input devices.

The cycle ends by updating the output. So, it will always go from phase 1, 2, 3, 4. It cannot go from 4 to 2 or 3 to 1, it follows the sequence. Once the output is done, it puts everything in the memory and the memory it is registered, from the memory, it goes to the output.

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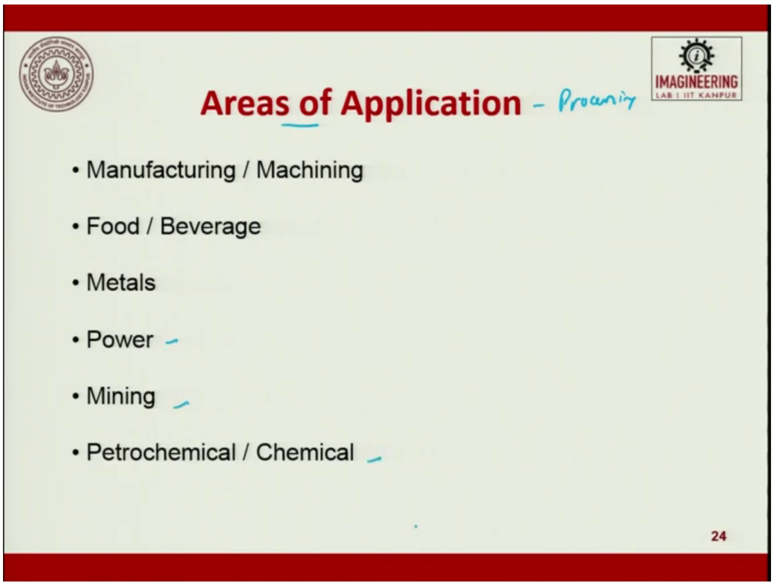

So, areas of applications. The most commonly used areas are going to be processing industry. So, as I told you it is manufacturing and machining industry, food and beverages, metal firming, all automation wherein required for primary processor we can do. It is for used automation exhaustively in power industry, mining industry, and petrochemical industry, PLC is exhaustively used. Even today, the need for a PLC programmer is huge. A smart PLC programmer has a huge weightage or gets a huge demand for today.

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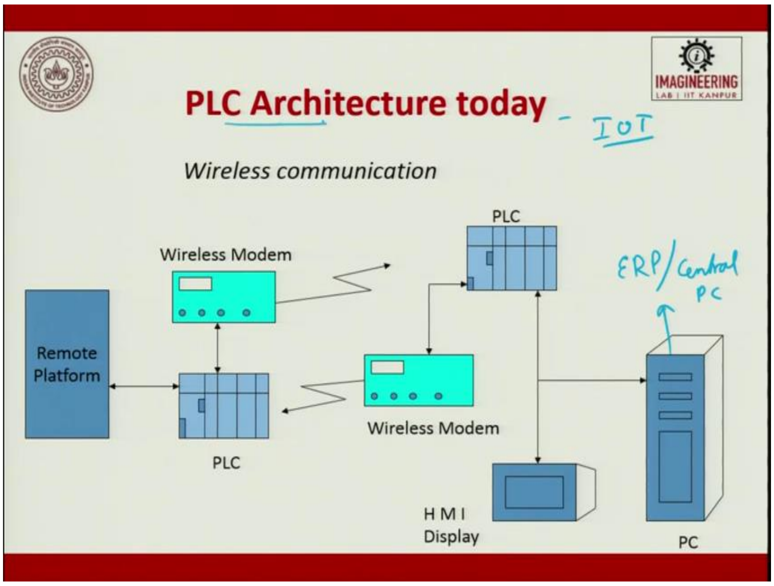

Till now we were talking about wired and the latest development had become wireless. When we are talking about IoT, the last lecture in this course, we will try to see what is IoT. What is industry 4.0? So you will understand more of this concept but as of now, you should understand today, the PLCs have started communicating in wireless mode. So, a remote platform is there, so you do not have to wire it.

So, the remote platform the data is gone to a PLC. PLC executes and transmits it to a wireless modem. Wireless modem, in turn, communicates with the machine or it communicates with the other PLCs or the other system. May it can be a computer where the server is for loading and unloading of devices, possible. So the platform is connected to PLC, then PLC to a wireless mode, then here also you will have a PLC attached to a wireless mode and this in turn, is attached to a PC. This PC can be an ERP software or it can be a central PC where the entire factory automation is controlled. So, this is the latest development of PLC architecture today.

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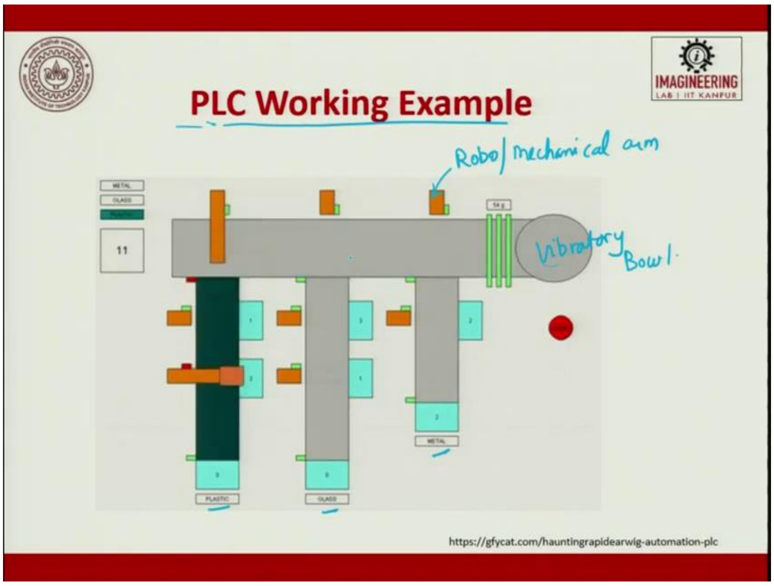

You can see a PLC live working example. Here, an object is from here moving. This can be your vibratory bowl and it tries to assess the path and moment it assesses the path, it tries to assess can be in terms of dimensions, assessment can be in terms of some color, whatever it is. So, it has moved from the vibratory bowl and then it looks into the color and from the color it gets this arm robot arm or just a normal mechanical arm gets activator and this mechanical arm, in turn, pushes it into a store.

Here, we have taken an example of metal, glass, and plastic, which is very commonly used in developed countries to sort out. See, in developed countries, they try to take recycled objects. So when they take a recycled object, for example, a tin, a beer tin, a beer bottle, and a plastic bottle. So what they do is, they just dump it in garbage hopper and from the garbage hopper, it is passed through a conveyor. It sorts and it activates, then it gets collected. This operation is done using a PLC. So, here it counts. Here it sensors. It is activated. This one is executed. So, the output sensor is the execution. The input sensor is nothing but processing the color or the material.

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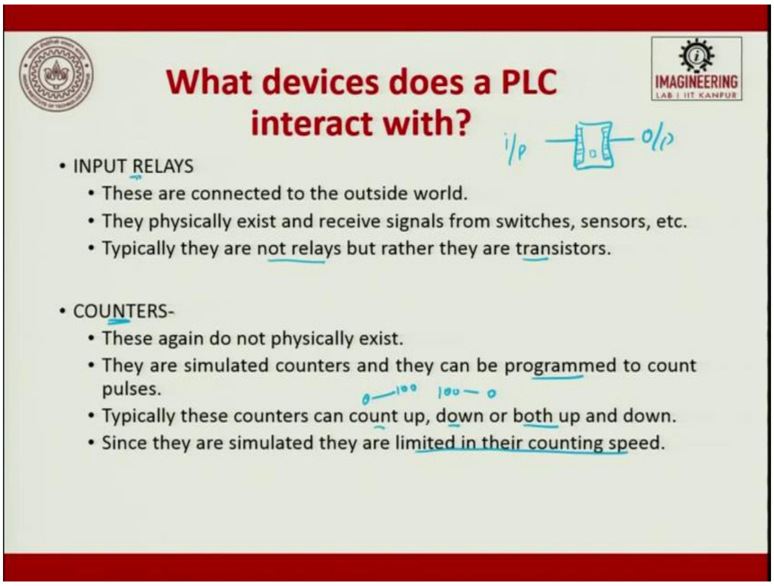

What devices does a PLC interact with? It interacts with input relays. These are connected to the output outside the world. So, PLC input is also outside world input, this is output. This is also output world but we can see but this is also an output world where we can see. So these are connected to the outside world. They physically exist and receive signals from switches and sensors.

So there are sensors, switches, etc. Typically, they are not relays but rather they are transistors. So, there are transistors, so relays are there. So it comes, these are all inputs. So if you take a PLC, this is all input side, these are all output side. Counter- these again do not physically exist. The moment I say counter, counter need not be a box. A counter can be a small space or it can be a memory space where counting can happen.

These again, do not physically exist. They are stimulated counter and they can be programmed to count pulses. So here, the physical counter is not there. So it is all inside memory and by an on and off of an event, it counts how many times the door has opened. For example, when you move in a train, the train what they have is? They have a sequential inspection of the bathroom cleaning and then coach cleaning.

Rather than that, depending upon the number of users if we do, then you can optimize the cleaning time and water usage. So here, what you have to do is every time, when the door is opened and closed, all you have to do is, you have to count. So, if the count is more than 50, then the time has come for cleaning.

So here, the count, 50 times counting will be done in a PLC in memory itself. So these are stimulated counter and they can be programmed to count down pulses. Typically, these counters can be up counter, down counter or it can be up-down counter. Up counter means, it goes from 0 to 100. Down counter means, it starts from 100 to 0. You can have a mixture of both. Since they are stimulated, they are limited in their counting speeds. So, a counter is a device with which is internal, these are input relays.

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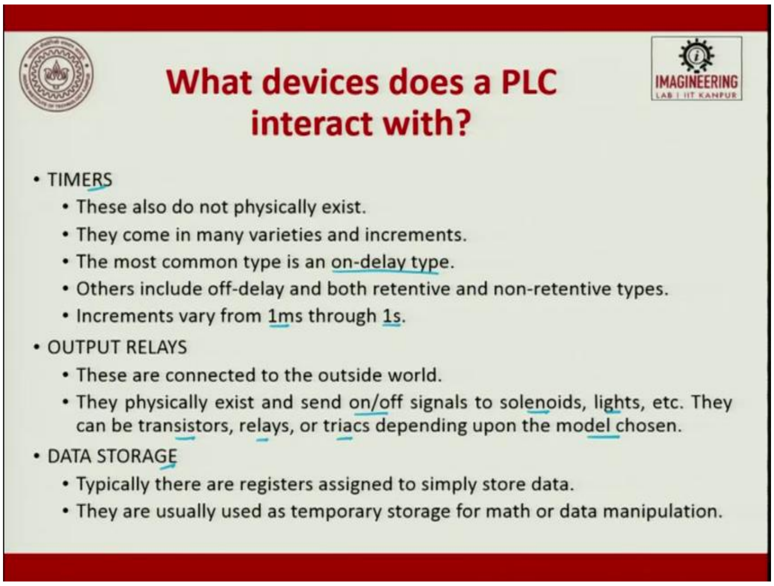

Then we have a timer. These timers also do not exist in physical form like a clock. It is inbuilt inside the PLC. So here, what happens, it counts internally. They are maybe in many varieties and increments. The most common type is an on-delay type. The other includes off-delay and both retentive and non-retentive types. The increment varies from 1 millisecond to 1 second.

The output relay, these are connected to the outside world. They physically exist and send on/off signals to solenoids, lights, etc. They can be transistor, relay, triac depending upon the model chosen. Data storage, typically there are registers assigned to simple store data. They are usually used as temporary storage for math or data manipulation.

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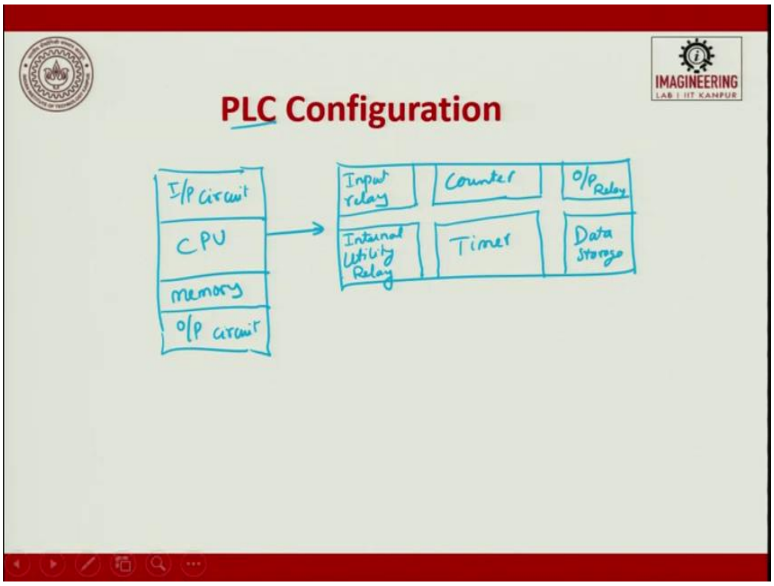

Let us now see the PLC configuration. For PLC configuration, which we have already seen but now I will put all the bits and piece information into one block diagram. So you have a CPU, you have a memory, you have an output circuit, you have an input circuit. This, in turn, is attached to data storage, so all the program, which is executed 1-0's, will be there.

This is the output relay and here you have a timer, you have a counter, you have internal utility relay and then you have input relay. So these are the six blocks, which are there in a PLC. You will have all these things plus these things inside, so you see a counter there, a timer there, data storage, output, internal utility array.

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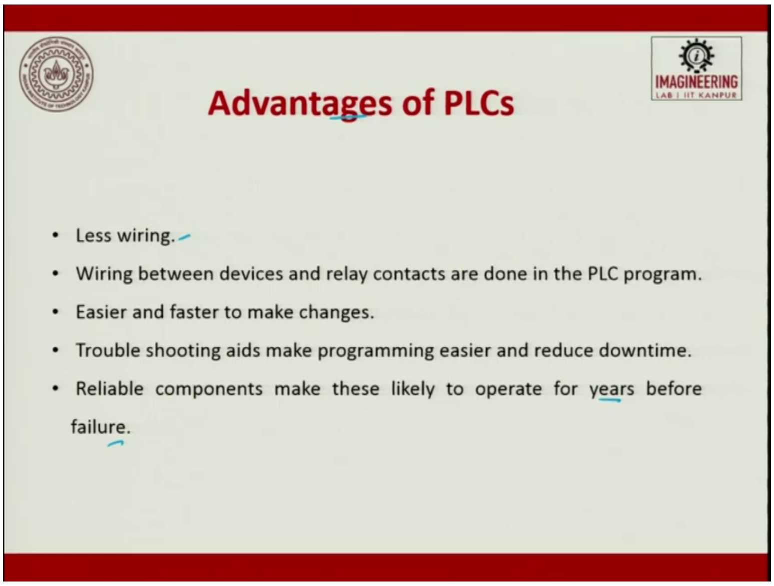

So what are the advantages of PLC? PLCs since earlier we used to have a lot of wire connections, now the PLC uses less wire. The wires between devices and relay contacts are done in the PLC program. Easier and faster to make changes. So since it is programmed based, it is very easy. Troubleshooting aids making the program easier and reducing downtime. Reliable components make also make this like to operate for years before failure.

So PLC gives you a major advantage. That is why it is completely trying to remove wires.

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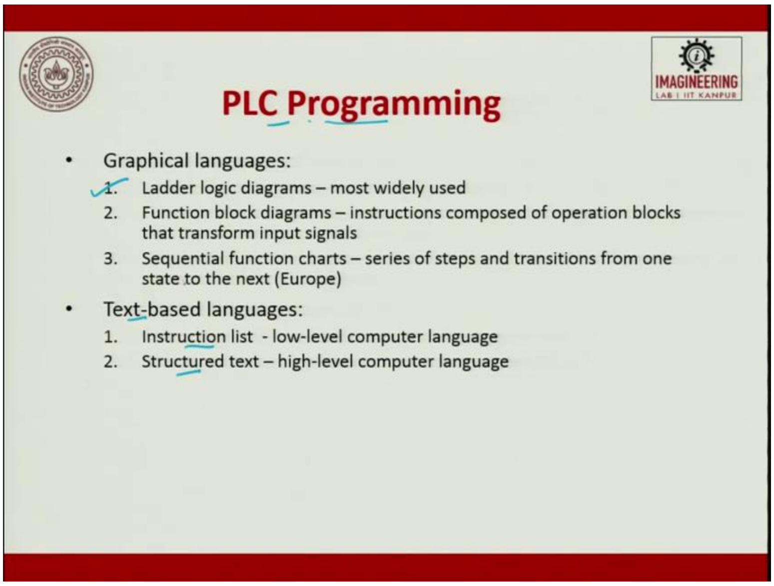

What are the different types of PLC program? We have graphical language, three. One is called a ladder logic diagram, most widely used. Function block diagram, instruction composed of operation blocs that transform into signals. Then, you will have a sequential function chart, series of steps, and transitions from one state to the next. So, these three are very commonly used and out of that ladder, logic diagram is the most common one. So, the next one, if you do not like to use the graphical form, like in CNC, you did not like to go for G codes and M codes. You have an APT. So like that, you will also have textual based languages, instruction lists, low-level computer language, structured text, which is a high-level computer language.

These are also used to program a PLC controller. These two are very important, function block diagram and sequential function chart. Function block diagram, instruction composed of operation blocks that transform input signal. Sequential is a series of steps and transitions.

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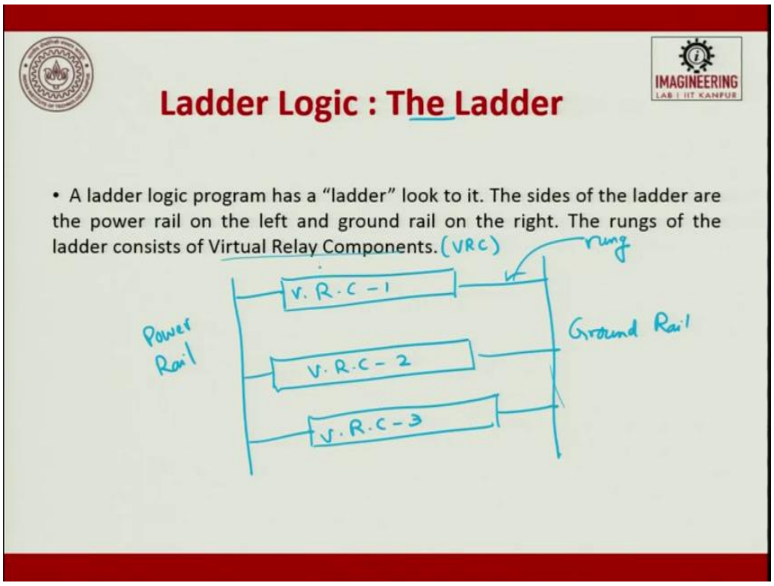

What is a ladder logic diagram? It is otherwise called as a ladder. A ladder logic program has a ladder look of it. The sides of the ladder are the power rails on the left and ground rails on the right. The rungs of the ladder consist of virtual relay components. So, for example, I will try to draw a ladder logic diagram. So, this is the power rail on one side. This is the ground rail on the other side and then you have rung.

This is called as a rung, R-U-N-G and this is virtual relay component 1, virtual relay component 2, and virtual relay component 3. A ladder logic program has a ladder look, which is like a ladder look. The sides of the ladder are powered rail on left and ground rail on right and then these two rails are connected by rungs and these rungs will have virtual relay components.

So here, you just put some components, virtually, and then try to say whether you have to only say the status on or off, and then accordingly, we will try to see the output.

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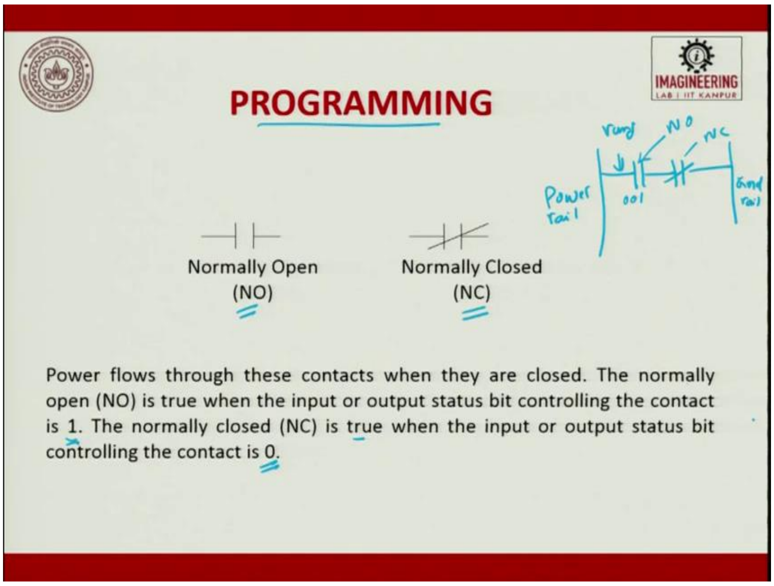

So, in the program, we can write using normally open and normally closed. So I said that in the rung, you can out normally open/normally closed and then you can write. So this is power rail, this is the ground rail, this is a rung and where you have virtual relay components and here are some sensors where we talk about normally open and normally closed. So, this is how we construct it. Here again, you have to declare this one. For example, you say 0-0-1 and then in the input, you say 0-0-1 switch is nothing but which connects it to a limit switch, which is in the door.

So you have to have all these data. So, the power flows from these contacts when they are closed. The normally open is true when the input or the output status bit controlling the contact is 1. The normally closed is true when the input or output status bit is controlled with 0. You can have normally open and normally closed. For, example, in light sensor assisted taps, normally it will be in a closed position and so no water comes.

When you try to cut the light and put your hand in between then this becomes open and you get water supply. The same analogy can be done vice versa also. So, it is a normally open state and this normally closed state. This is put in a rung and several of these things are put together to form your ladder logic diagram.

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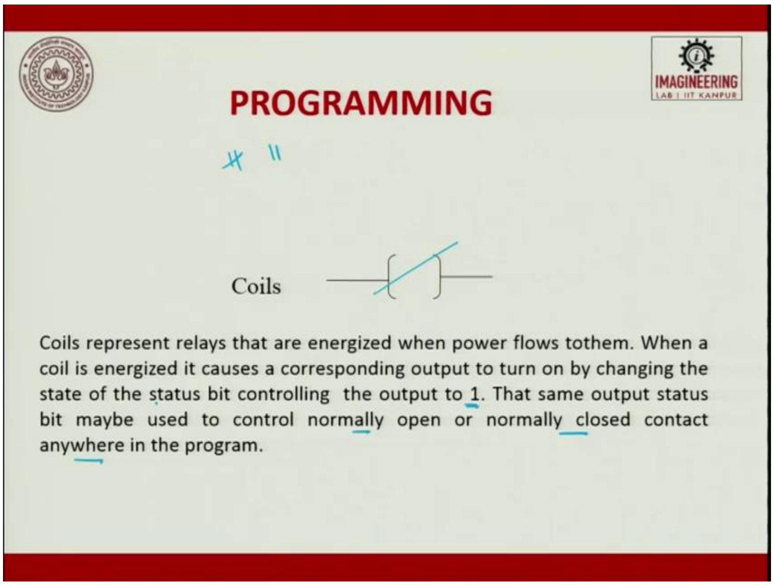

A coil represents relay that is energized when power flow to them. When a coil is energized, it causes a corresponding output to turn on by changing the state of the status bit controlling the output to 0. That same output status bit may be used to control normally open or normally closed contact anywhere in the program. So, are you able to understand? Coils represent relay. These are coils, so you can have normally closed and normally open and then this in turn, attached to your coil.

Coil represent relay that is energized when power flow to them. So if you change the status, this can be closed. When a coil is energized, it causes a corresponding output to turn on by changing the state of the status bit controlling the output to on.

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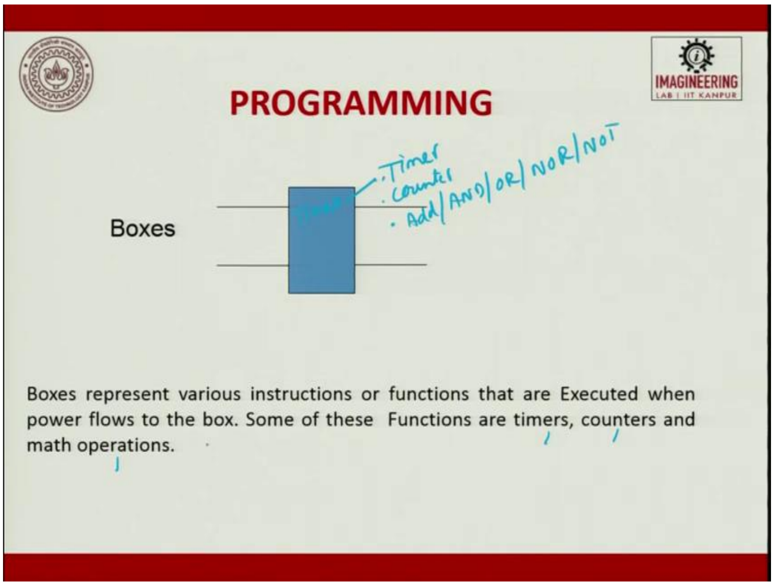

You can also have boxes. Boxes represent various instructions or functions that are executed when the power flows to the box. Some of these functions are a timer, counter, and other math operations. So, if you want to put a, if you want to put a counter or if you do an addition or AND operation or OR operation or NOR operation or NOT operations, we try to use this box.

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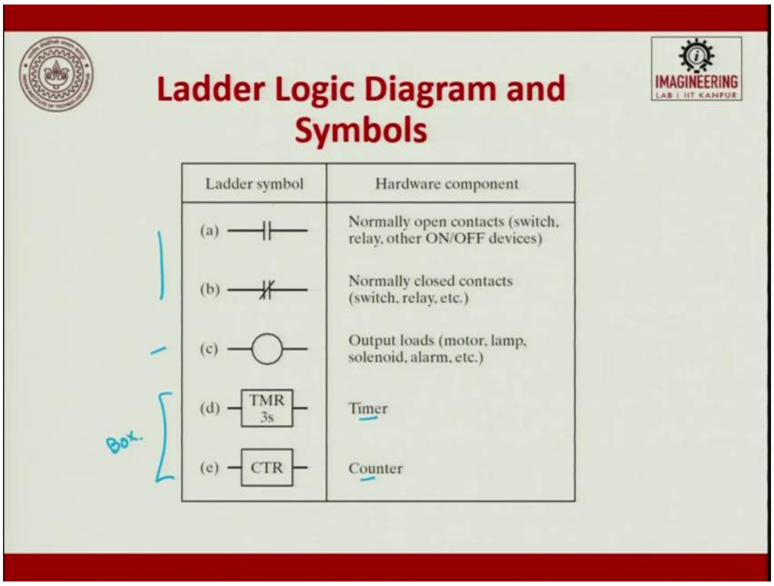

So, in a ladder logic diagram, these are the symbols used. Normally the open contact, switch, relay, other on/off devices, we give this. When normally closed, we say this. When output loads such as motor, lamps these are for inputs. These are output loads of motor, lamps, solenoid, alarm, etc. we put this. And we put a box for a timer. We put this for the counter. So, now whatever I said in this prior we have seen input, output then these are boxes.

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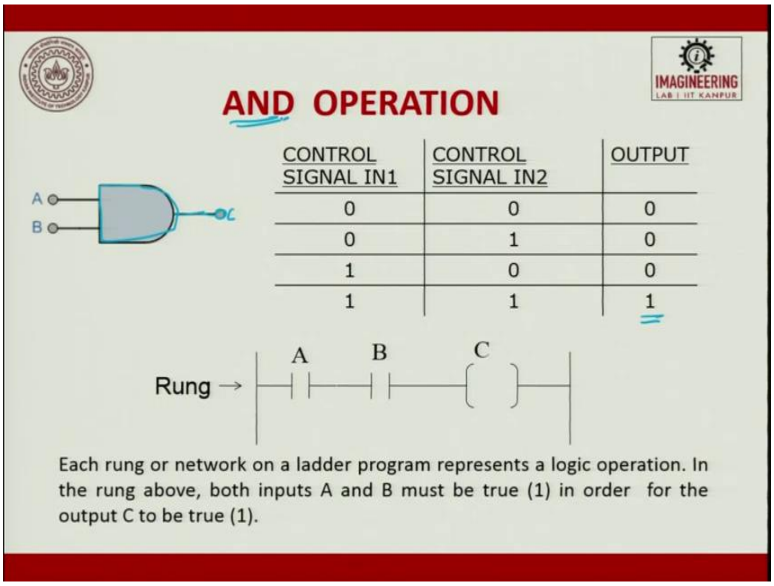

AND operation. This is how you try to draw your device. So, which is it has two in and one out. So the control signal in 1 is 0. The control signal in 2 is 0. The output will be 0. So, the control signal will be 0, B will be 1 and the output will be 0. If the control signal is 1 and B is also 1 and then now you will try to get an output as 1. So, now what you will do is, you will write this program in this form, whatever we did here, we will write it in one rung information.

An input, B input, C is the coil, you get the output. Each rung or the network on the ladder program represents a logical operation. In the rung above, both the input A and B must be true in order for C to be true. So, this entire table now is represented in this one rung and several of these rungs are attached. So, A and B in turn can be attached to a field sensor that is giving input to the signal. What we saw here is for AND operation. We will also see for NOR operation.

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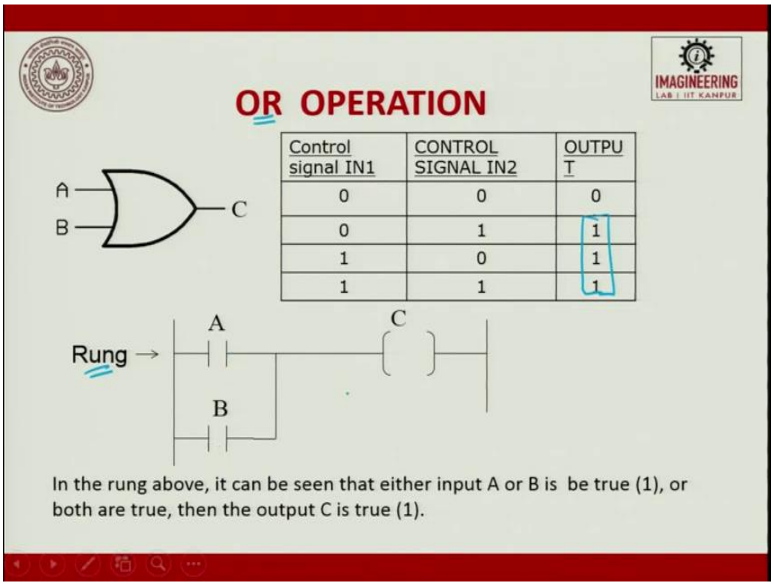

NOR operation. If A is 0, B is 0. C will be 0. If A is 1, B is 0. C will be 1. If B is 1, A is 0, C will be 1 and if A and B are 1 then C will be 1. So, you can see is nothing but an OR signal. So, this can be represented in a rung form like this. A, B OR form. If it is AND, it will be together. If it is rung OR type then the rung will have like this. In the above rung, it can be seen either A or B, if it is true then C will be true.

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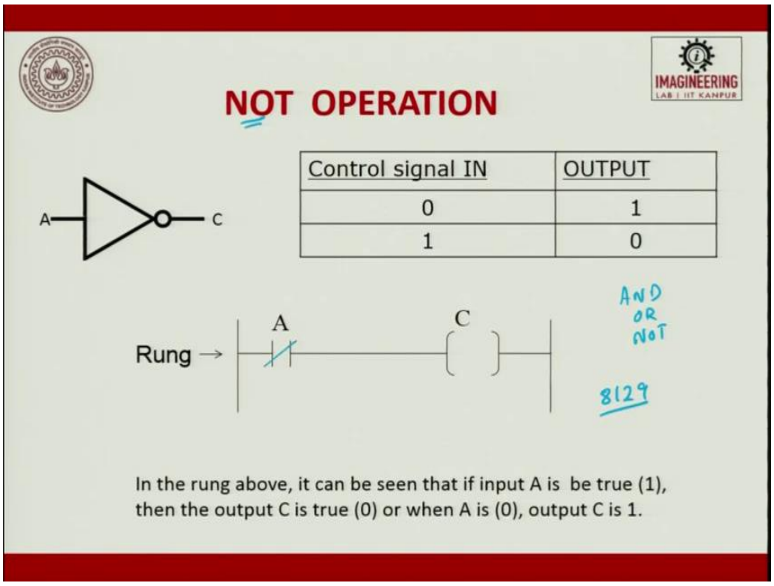

You can also have your NOT operation. If A is 0, B will be 1 or C will be 1. If A is 1, C will be 0. So here, you can see that A is normally closed and you put this. If the rung above, it can be seen that if the input is true then the output is true-0 or when input is 0, the output will be 1, so this is for NOT. So, we saw AND, OR, NOT three logics we saw. Like this, if you can put ladder by ladder by ladder. By rung by rung by rung in a ladder diagram then you can try to control. Today we are talking about controlling 8129 input/output devices. Let us take half of it, somewhere close to 4000 in can be done. So, the ladder logic diagram will run for a thousand runs today.

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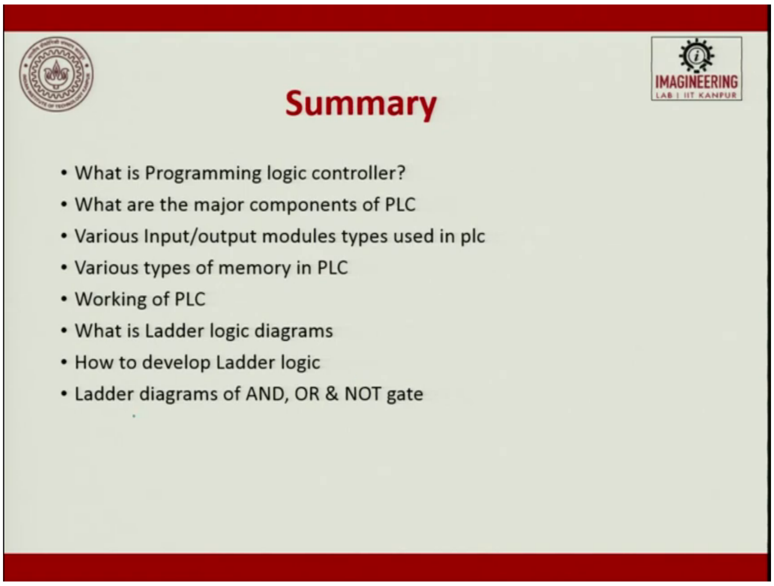

To summaries, what we saw in a PLC? We saw what is a programmable logic controller. What are all the major components of a PLC? What is the input/output modules? What are the types of memories in PLC? How does PLC work? What is a ladder logic diagram? How to develop a ladder logic diagram. Ladder for AND, OR, NOT was done. Thank you.