Automation in Production Systems and Management
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Fundamentals of NC Technology - I
Lecture - 19
Features of CNC, Configuration of CNC Machine Control System

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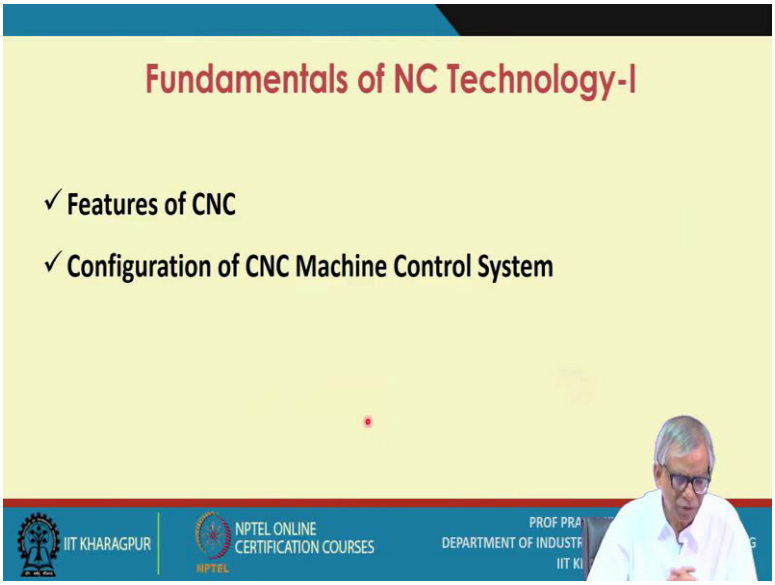

During this lecture session I will discuss two important topics and both are the related to CNC (Computer Numerical Control) system that is features of CNC and configuration of CNC Machine Control System.

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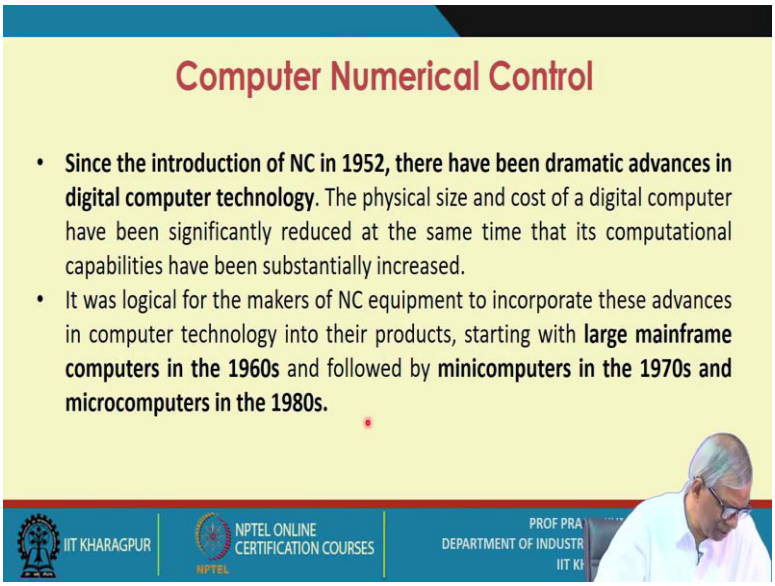

Now, let us just go through certain features or certain historical background related to CNC. Since the introduction of NC in 1952, there have been dramatic advances in the digital computer technology. The physical size and cost of a digital computer have been significantly reduced. That is why digital technology should be adopted. At the same time the computational capabilities have been substantially increased. There is no doubt about it. Today, the capability of a computer is almost infinite, huge. It was not so in 50s, 60s, even in 70s, even in 90s also.

It was logical for the makers of NC equipment to incorporate these advances in computer technology into their products, starting with large mainframe computers in the 1960s and followed by minicomputers in the 1970s and microcomputers in the 1980s.

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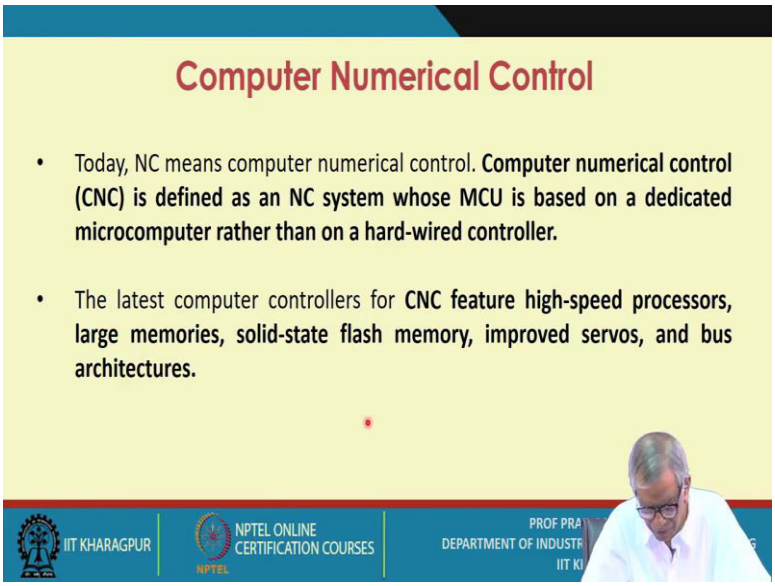

Today, NC means computer numerical control. Computer numerical control is defined as NC system whose MCU is based on a dedicated microcomputer rather than on a hardware controller. So, initially in 50s and the 60s early 60s, for the specific parts or machine tool you have to design the MCU separately, only for group of parts and for a specific machine tool these MCU is applicable, it is basically a special purpose design. There are a lot of limitations. Today MCU is totally replaced by a computer and the flexibility of a computer system.

The latest computer controllers for CNC feature high speed processors, large memories. Solid-state flash memory improved servos and bus architectures. These are the features of a typical computer based NC systems.

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These are the features of CNC; the first one is the storage of more than one part program. Simultaneously you can store not only one part program, but you can store a large number of part programs.

Second one is the storage capacity, has improved various forms of program input various forms.

Editing is a part of job, the fixed cycles and programming subroutines. You can use several kinds of subroutines, many of them may be kind of specific the software, interpolation software one can really use. You can refer to that interpolation software in your programming. Positioning features for the setup, cutter length and size compensation, Acceleration and deceleration calculations, Communications interface, Diagnostics

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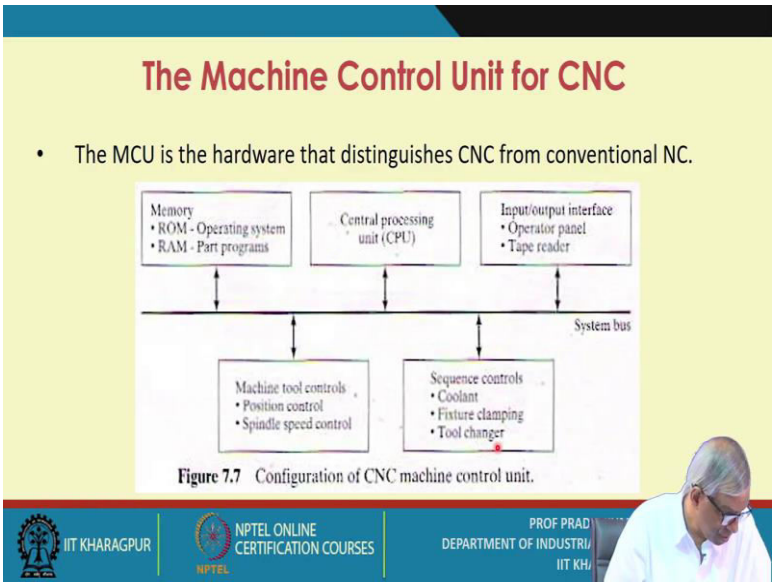

MCU is the hardware that distinguishes CNC from conventional NC.

In the computer system you find the Read Only Memory (ROM) and you have random access memory.

So, the part programs you can store over there; then you have the Central Processing Unit CPU have input output interface. Operator panel and absolutely the tape reader, this is basically a sub system called input output interface. Now, there is the communication line, the system bus and the machine tool controls.

The position control systems and the spindle speed control. These are the two important aspects you need to consider and you have to also have the sequence control like coolant, the fixture clamping and the tool changes. These comes under sequence control.

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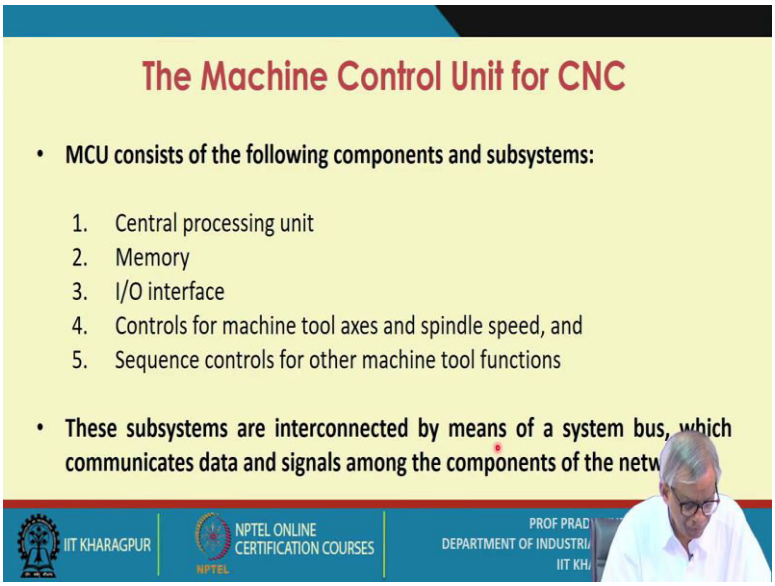

MCU consists of the following components and subsystems: Central processing unit, memory, input-output interface, controls for machine tool axes and the spindle speeds and the sequence controls for other machine tool functions. These sub systems are incorporated by means of a system bus which communicates data and signals among the components of the network.

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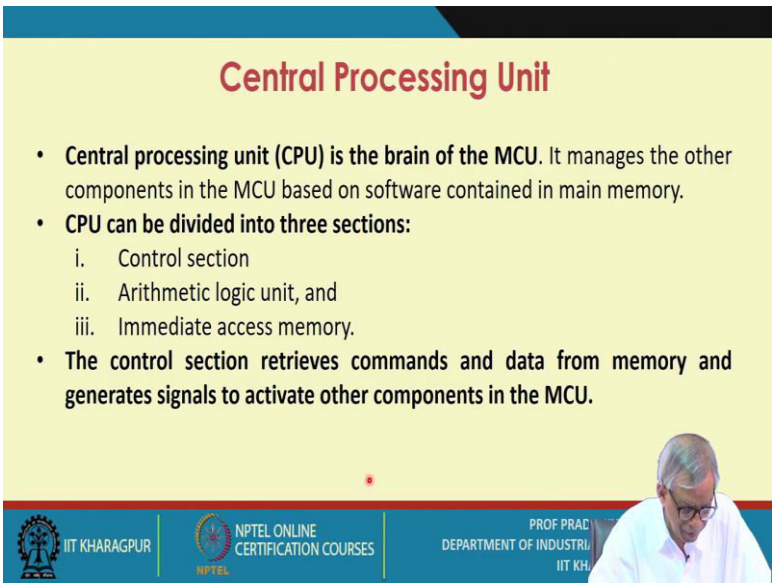

The CPU is the brain of the MCU that is known to you, it manages the other components in the MCU based on software content in main memory.

CPU can be divided into 3 sections control section, arithmetic logic unit (ALU), and immediate access memory. The control section retrieves commands and data from memory and generate signals to activate other components in the MCU.

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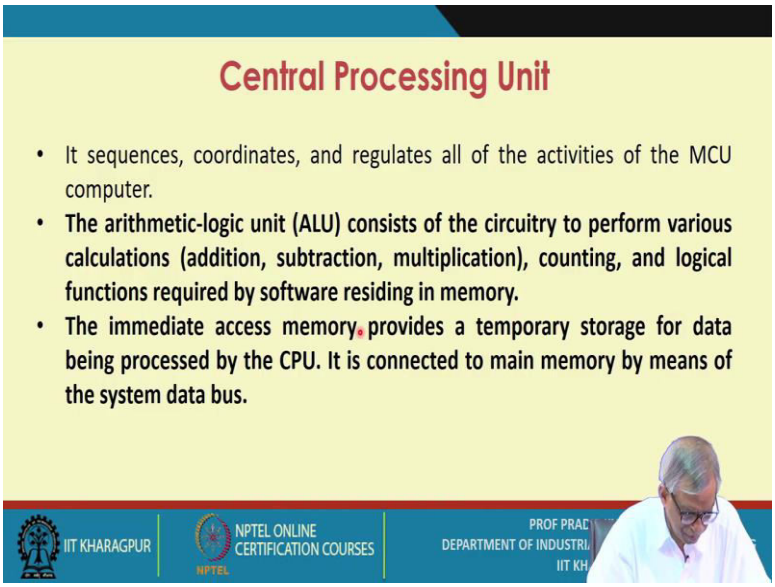

CPU coordinates is basically the brain of the computer. It sequences, coordinates, and regulates all of the activities of the MCU computer. Arithmetic logic unit consist of the circuitry to perform various calculations like addition, subtraction, multiplication, counting and logical functions required by software are residing in memory.

The immediate access memory provides a temporary storage for data being processed by the CPU. It is connected to main memory by means of the system data bus.

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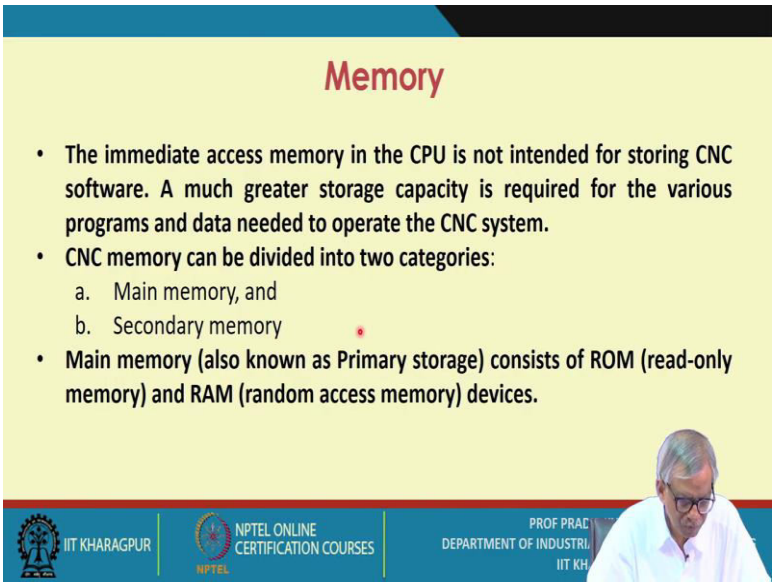

The immediate access memory in the CPU is not intended for storing CNC software. A much greater storage capacity is required for the various programs and data needed to operate the CNC system.

CNC memory can be divided into two categories: Main memory, and Secondary memory

Main memory (also known as Primary storage) consists of ROM (read-only memory) and RAM (random access memory) devices.

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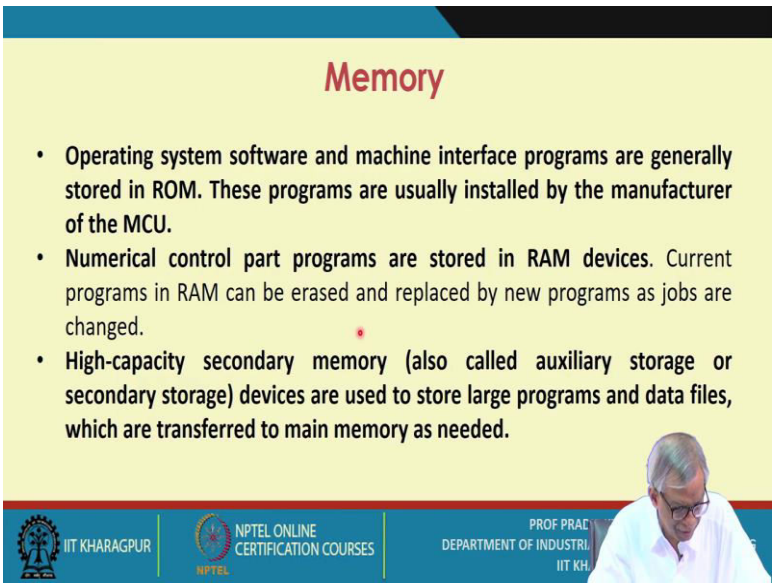

Operating system software and machine interface programs are generally stored in ROM. These programs are usually installed by the manufacturer of the MCU. Numerical control part programs are stored in RAM devices. Current programs in RAM can be erased and replaced by new programs as jobs are changed. High-capacity secondary memory (also called auxiliary storage or secondary storage) devices are used to store large programs and data files, which are transferred to main memory as needed.

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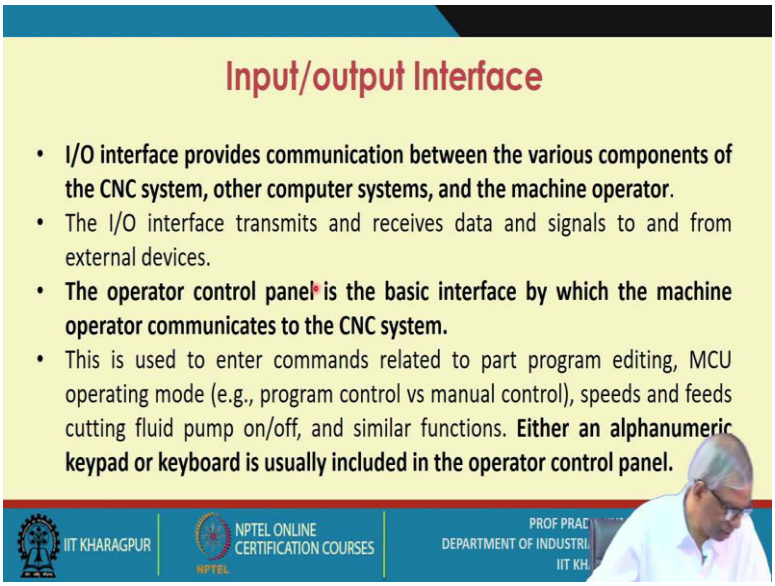

The I/O interface provides communication between the various components of the CNC system, other computer systems, and the machine operator. The I/O interface transmits and receives data and signals to and from external devices. The operator control panel is the basic interface by which the machine operator communicates to the CNC system. This is used to enter commands related to part program editing, MCU operating mode (e.g., program control vs manual control), speeds and feeds cutting fluid pump on/off, and similar functions. Either an alphanumeric keypad or keyboard is usually included in the operator control panel.

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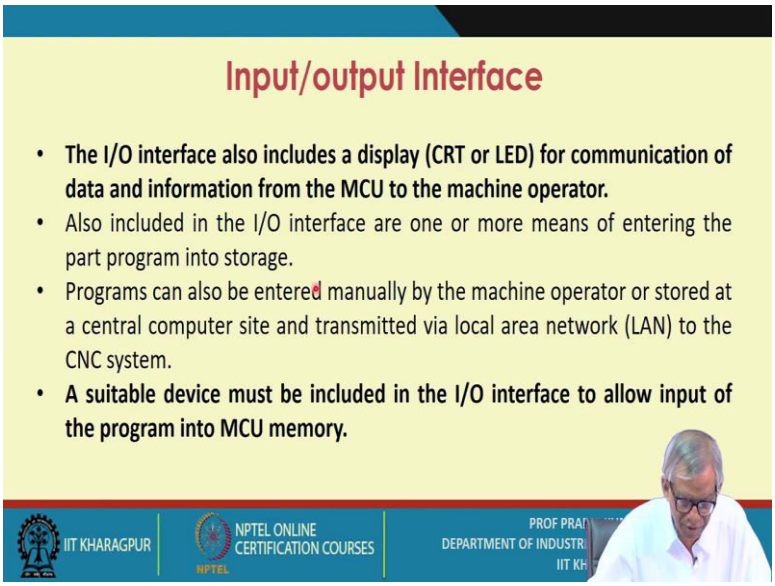

The I/O interface also includes a display (CRT or LED) for communication of data and information from the MCU to the machine operator. Also included in the I/O interface are one or more means of entering the part program into storage. Programs can also be entered manually by the machine operator or stored at a central computer site and transmitted via local area network (LAN) to the CNC system. A suitable device must be included in the I/O interface to allow input of the program into MCU memory.

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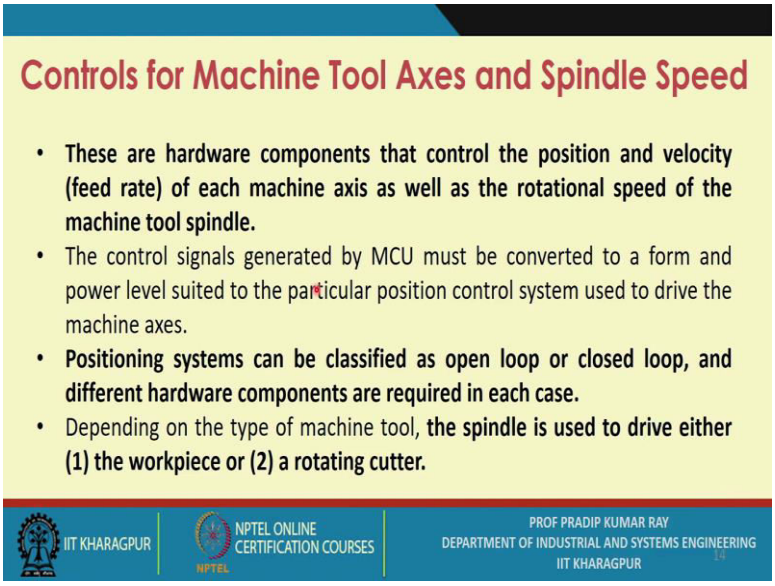

These are the hardware components that control the position and velocity for feed rate of each machine axis as well as the rotational speed of the machine tool spindle. These are the two important aspects we referring to.

The control signals generated by MCU must be converted to a form and power level suited to the particular position control system used to drive the machine axes. So, positioning systems can be classified as open loop or close loop and the different hardware components are required in each case.

The spindle is used to drive either the workpiece or the rotating cutter.

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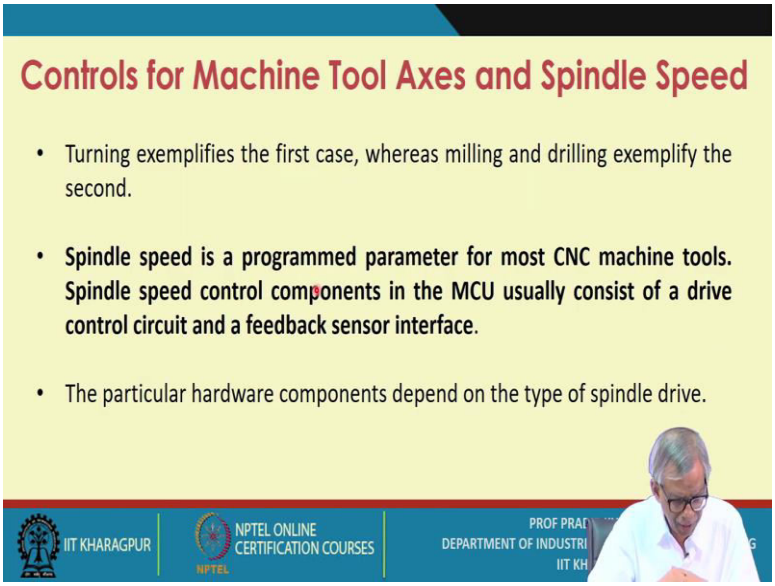

Turning exemplifies the first case, whereas milling and drilling exemplify the second one.

Spindle speed is a programmed parameter for most CNC machine tools. Spindle speed control components in the MCU usually consists of a drive control circuit and a feedback sensor interface. The particular hardware components depend on the type of spindle drive.

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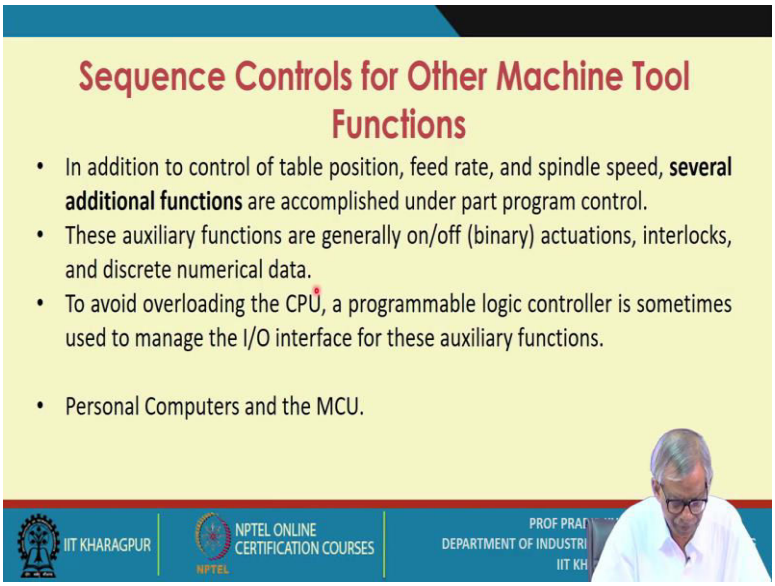

The next one is the sequence control. There is a process plan and there is a sequence of operations to be carried out. In addition to control of table position, feed rate, and spindle speed, several additional functions are accomplished under part program control.

These auxiliary functions are generally on/off (binary) actuations, interlocks, and discrete numerical data.

To avoid overloading the CPU, a programmable logic controller is sometimes used to manage the I/O interface for these auxiliary functions.

Personal Computers and the MCU.

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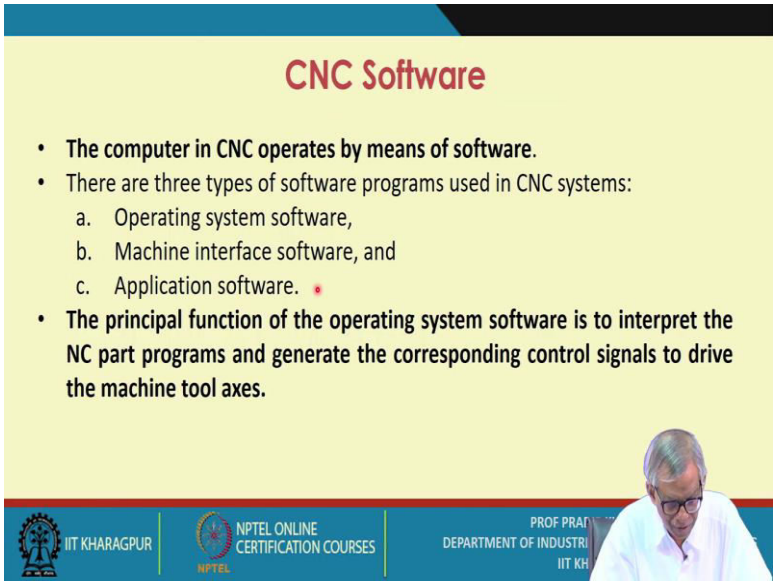

Now, you need to use several kinds of the software, let us have some the knowledge on this software what actually it does and why it is used. The computer in CNC operates by means of software. There are three types of software programs used in CNC system; three types.

Operating system software, machine interface software. And next one is the application software. typical interpolation software, application software. The principal function of the operating system software is to interpret the NC part programs and generate the corresponding control signals to drive the machine tool axes.

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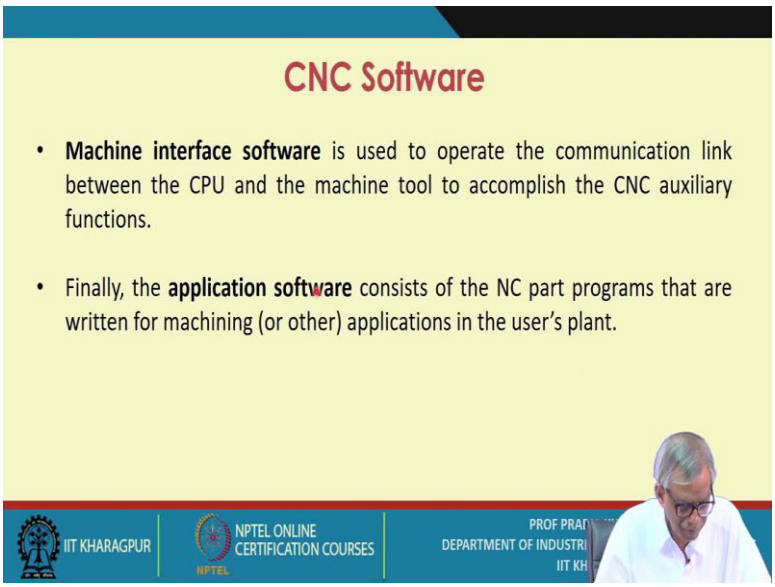

Machine interface software is used to operate the communication link between the CPU and the machine tool to accomplish the CNC auxiliary functions. With one particular CNC or in a particular CNC system; not only you can engage one machine tool, but n number of machine tools, a large number of machine tools.

Like one computer can handle not only one machine tool, but in large number of machine tools. So, when NC system was introduced when NC system was introduced in 50s, immediately after NC system that is numerical control system there was DNC (Direct Numerical Control), the main frame computer where large number of the machine tools can be handled. And during those days it was the declared that they have developed the DNC direct numerical control where with one computer you can handle 256 machine tools, not only in one location, but they could be located in different places.

During those days that was a great achievement. So, machine interface software is used to operate the communication link between the CPU and the machine tool to accomplish the CNC auxiliary functions. Finally, the application software consists of the NC part programs that are written for machining or other applications in the user's plant.

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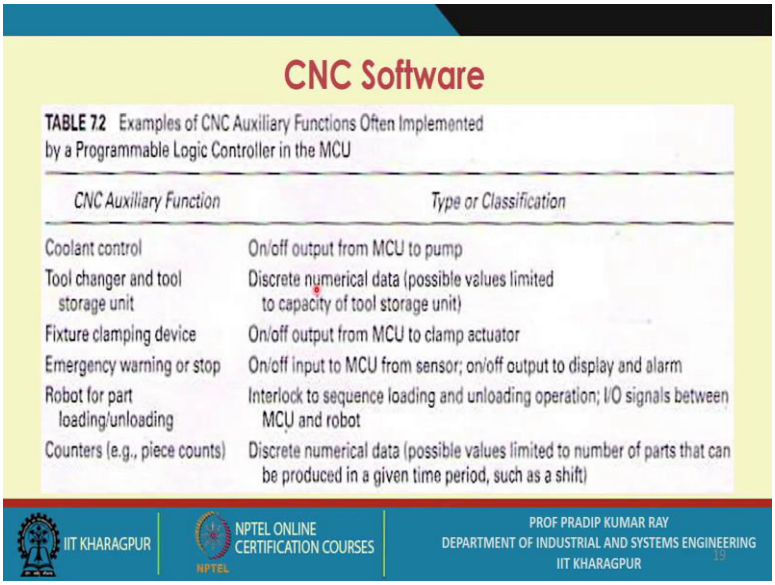

This table basically have list of CNC or what are the auxiliary functions and the type of classifications like coolant control, tool changer and tool storage unit are several examples.

Given fixture clamping device you identify, emergency warning or stop automated system, robot for part loading unloading. Counters that means, how many pieces the machine is on. How many pieces you have produced. So, those are basically known as the counters and these are the classifications, these are all there.

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