USN	1	C	R			M	E			

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Internal Assessment Test 3 – Nov. 2018

Sub:	Mechatronics					Sub Code:	15ME754	Branch:	ME	
Date:	20/11/2018	Duration:	90 min's	Max Marks:	50	Sem / Sec:	VII A&B		OBE	

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1	With help of block diagram explain the internal structure of PLC.	[10]	CO3	L2
2	Explain DPDT and limit switch.	[10]	CO3	L2
3	Explain XOR logic function and latching in PLC	[10]	CO3	L2

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4	Explain the construction and working of stepper motor	[10]	CO4	L2
5	List and explain the criteria for PLC selection.	[10]	CO4	L2
6	With block diagram explain the functional requirements of industrial robot.	[10]	CO4	L2
7	With neat diagram explain i) Ratchet and pawl mechanism. ii) Cylindrical cam.	[10]	CO4	L3
8	Write short note on i) Gear train. ii) Mechanical aspects of motor selection.	[10]	CO4	L3

CI CCI HOD

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Answer any FIVE FULL Questions

		MARKS	CO	RBT
1	With help of block diagram explain the internal structure of PLC.	[10]	CO3	L2

between the input/output ports ...

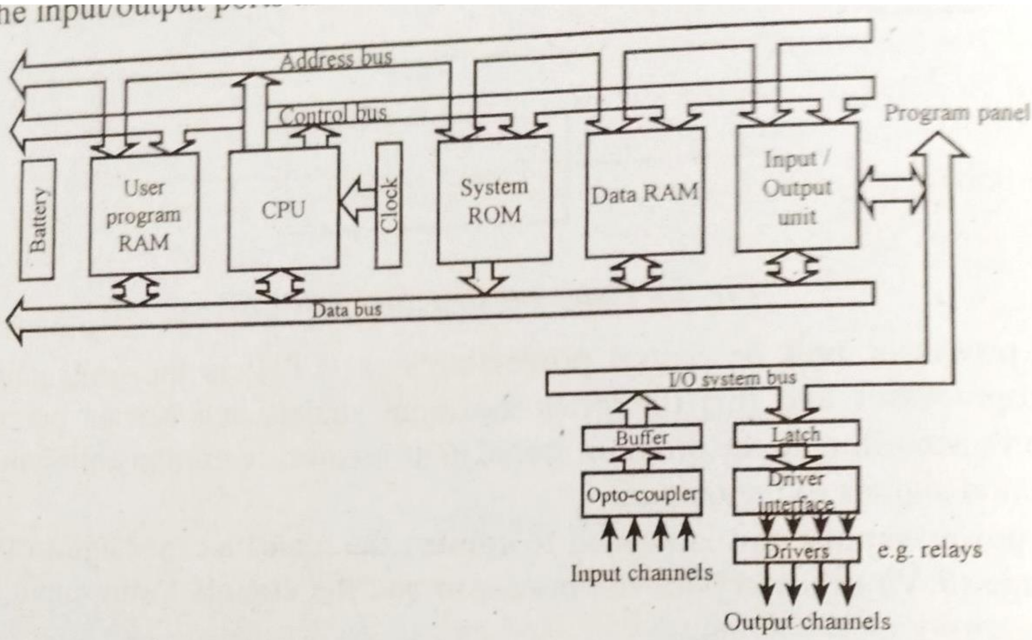


Fig 3.3 Internal structure of PLC

1) **The CPU:** The internal structure of the CPU depends on the microprocessor concerned. In general they have:

a) An arithmetic and logic unit (ALU) which is responsible for data manipulation and carrying out arithmetic operations of addition and subtraction and logic operations of AND, OR, NOT and EXCLUSIVE-OR.

b) Memory, termed registers, located within the microprocessor and used to store information involved in program execution.

c) A control unit which is used to control the timing of operations.

2) **The buses :** The buses are the paths used for communication within the PLC. The information is transmitted in binary form, i.e. as a group of bits with a bit. The system has four buses:

a) The data bus carries the data used in the processing carried out by the CPU. A microprocessor termed as being 8-bit has an internal data bus which can handle 8-bit numbers. It can thus perform operations between 8-bit numbers and deliver results as 8-bit values.

b) The address bus is used to carry the addresses of memory locations. So that each word can be located in the memory, every memory location is given a unique address

c) The control bus carries the signals used by the CPU for control, e.g. to inform memory devices whether they are to receive data from an input or output data and to carry timing signals used to synchronise actions.

d) The system bus is used for communications between the input/output ports and the input/output unit.

3) **Memory:** There are several memory elements in a PLC system:

a) System read-only-memory (ROM) to give permanent storage for the operating system and fixed data used by the CPU.
b) Random-access memory (RAM) for the user's program.
c) Random-access memory (RAM) for data, where information is stored on the status of input and output devices and the values of timers and counters and other internal devices.
d) Erasable and programmable read-only-memory (EPROM) for ROMs that can be programmed and then the program made permanent.

4) Input/output unit:

The input/output unit provides the interface between the system and the outside world, allowing for connections to be made through input/output channels to input devices such as sensors and output devices such as motors and solenoids. It is also through the input/output unit that programs are entered from a program panel. Every input/output point has a unique address which can be used by the CPU

5) Sourcing and sinking

The terms sourcing and sinking are used to describe the way in which d.c. devices are connected to a PLC.

With sourcing, using the conventional current flow direction as from positive to negative, an input device receives current from the input module, i.e. the input module is the source of the current as shown in fig 3.4 a. If the current flows from the output module to an output load then the output module is referred to as sourcing Fig 3.4 b .

With sinking, using the conventional current flow direction as from positive to negative, an input device supplies current to the input module, i.e. the input module is the sink for the current Fig3.5a. If the current flows to the output module from an output load then the output module is referred to as sinking Fig 3.5b.

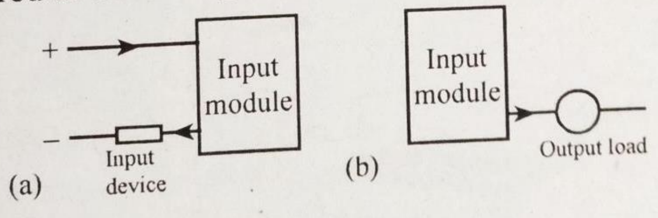


Fig 3.4 (a)Sourcing

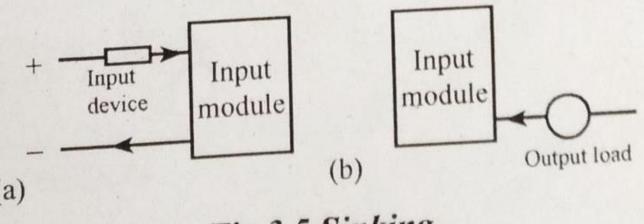
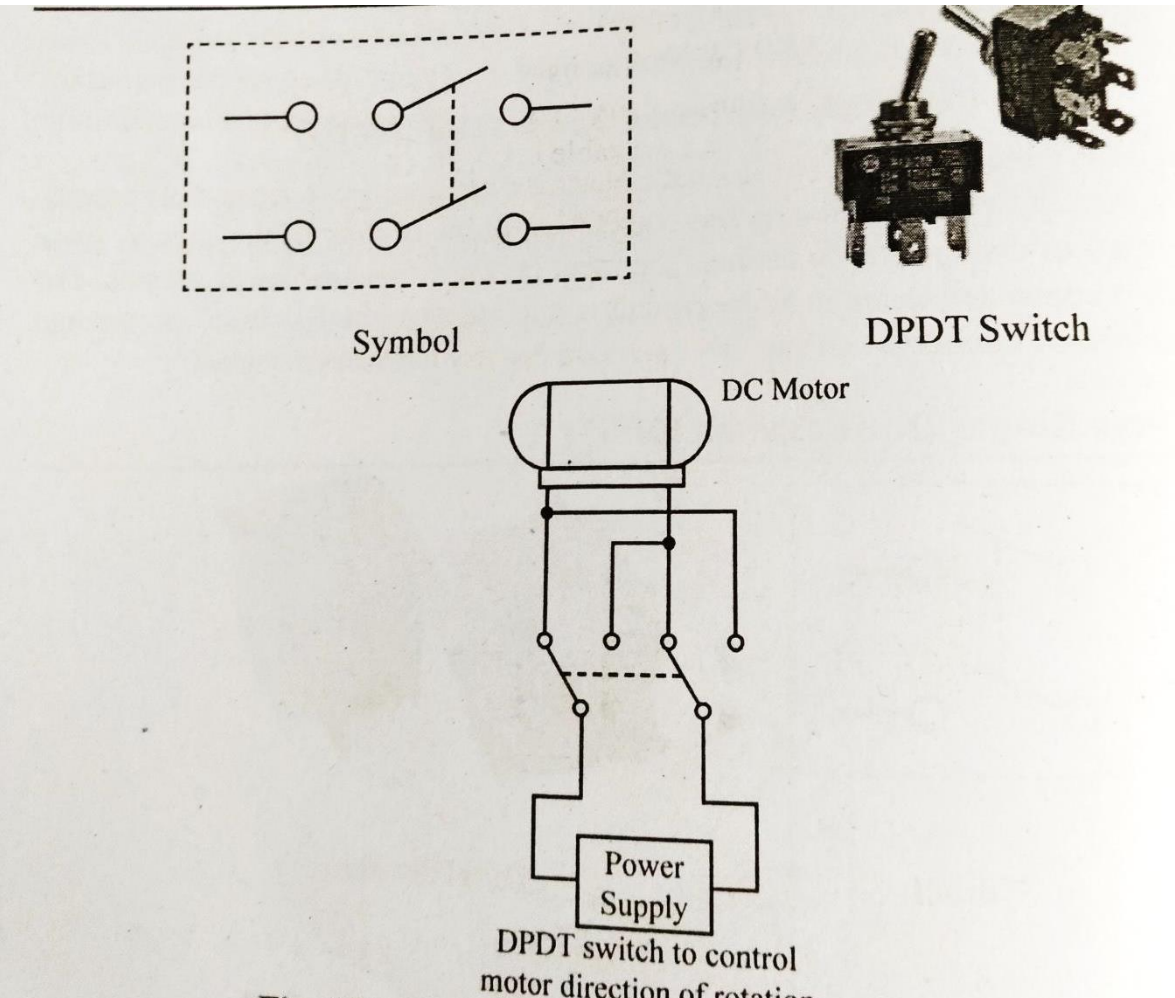


Fig 3.5 Sinking

2	Explain DPDT and limit switch.	[10]	CO3	L2



This is a dual ON/OFF switch consisting of two ON positions. It has six terminals,two are input contacts and remaining four are the output contacts. It behaves like a two separate SPDT configuration, operating at the same time. Two input contacts are connected to the one set of output contacts in one position and in another position, input contacts are connected to the other set of output contacts.

C. Limit Switch

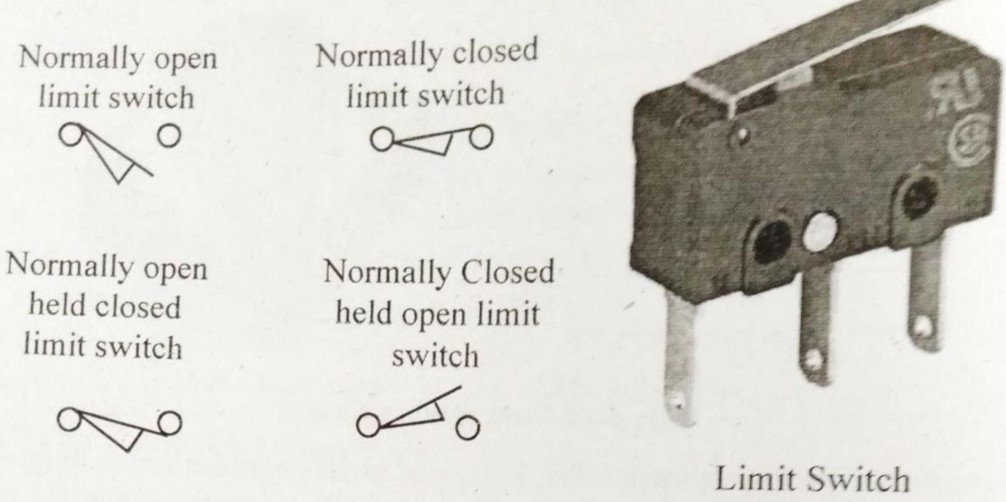


Fig. 4.24 Limit Switch

The control schemes of a limit switch are shown in above figure , in which four varieties of limit switches are presented. Some switches are operated by the presence of an object or by the absence of objects or by the motion of machine instead of human hand operation. These switches are called as limit switches. These switches consist of a bumper type of arm actuated by an object. When this bumper arm is actuated, it causes the switch contacts to change position.

3	Explain XOR logic function and latching in PLC	[10]	CO3	L2

6) Exclusive OR (XOR)

The OR gate gives an output when either or both of the inputs are 1. Sometimes there is, however, a need for a gate that gives an output when either of the inputs is 1 but not when both are 1, i.e., has the truth table:

Inputs		Output
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

Such a gate is called an Exclusive OR or XOR gate. One way of obtaining such a gate is by using NOT, AND and OR gates as shown in Figure

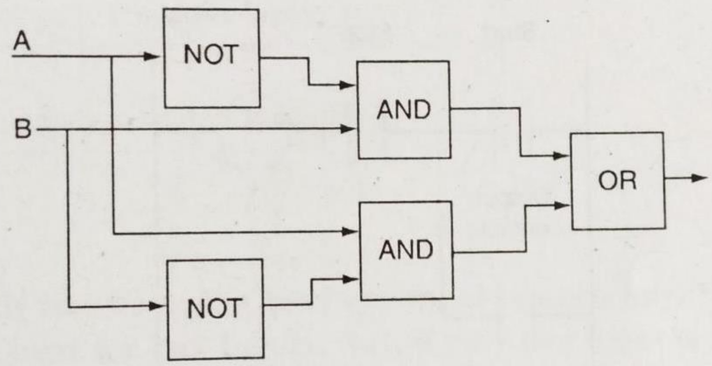
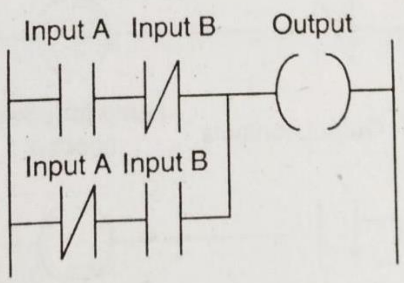


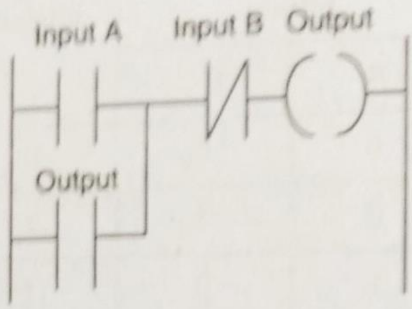
Figure shows a ladder diagram for an XOR gate system



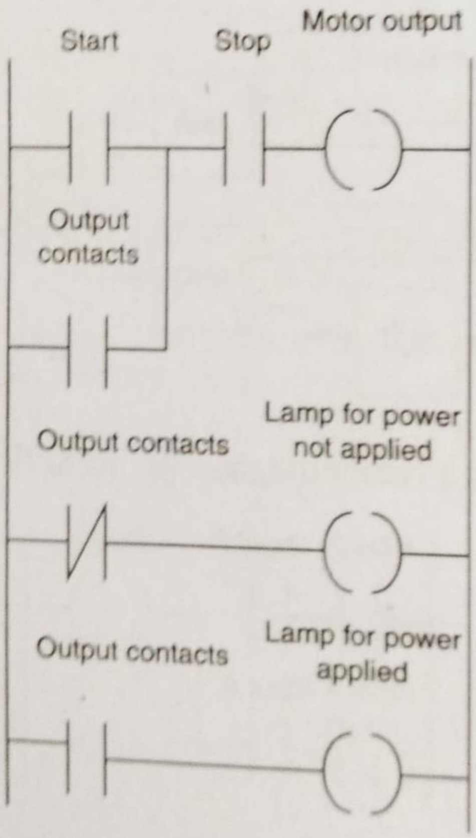
3.5 Latching:

There are often situations where it is necessary to hold an output energized, even when the input ceases. A simple example of such a situation is a motor, which is started by pressing a push button switch. Though the switch contacts do not remain closed, the motor is required to continue running until a stop push button switch is pressed. The term latch circuit is used for the circuit used to carry out such an operation. It is a self-maintaining circuit in that, after being energized, it maintains that state until another input is received.

An example of a latch circuit is shown in Figure. When the input A contacts close, there is an output. However, when there is an output, another set of contacts associated with the output closes. These contacts form an OR logic gate system with the input contacts. Thus, even if the input A opens, the circuit will still maintain the output energized. The only way to release the output is by operating the normally closed contact B.



As an illustration of the application of a latching circuit, consider a motor controlled by stop and start push button switches and for which one signal light must be illuminated when the power is applied to the motor and another when it is not applied. Figure below shows the ladder diagram



4	Explain the construction and working of stepper motor	[10]	CO4	L2

5 List and explain the criteria for PLC selection. [10] CO4 L2

3.6 PLC selection

PLC can be selected based on following criteria's

System requirements

- The starting point in determining any solution must be to understand what is to be achieved.
- The program design starts with breaking down the task into a number of simple understandable elements, each of which can be easily described.

Application requirements

- Input and output device requirements. After determining the operation of the system, the next step is to determine what input and output devices the system requires.
- List the function required and identify a specific type of device.
- The need for special operations in addition to discrete (On/Off) logic.
- List the advanced functions required beside simple discrete logic.

Electrical Requirements

The electrical requirements for inputs, outputs, and system power; When determining the electrical requirements of a system, consider three items:

- Incoming power (power for the control system);
- Input device voltage; and
- Output voltage and current.

Speed of Operation

How fast the control system must operate (speed of operation).

When determining speed of operation, consider these points:

- How fast does the process occur or machine operate?
- Are there "time critical" operations or events that must be detected?
- In what time frame must the fastest action occur (input device detection to output device activation)?
- Does the control system need to count pulses from an encoder or flow-meter and respond quickly?

Communication

If the application requires sharing data outside the process, i.e. communication. Communication involves sharing application data or status with another electronic device, such as a computer or a monitor in an operator's station. Communication can take place locally through a twisted-pair wire, or remotely via telephone or radio modem.

Operator Interface

If the system needs operator control or interaction. In order to convey information about machine or process status, or to allow an operator to input data, many applications require operator interfaces. Traditional operator interfaces include pushbuttons, pilot lights and LED numeric display. Electronic operator interface devices display messages about machine status in descriptive text, display part count and track alarms. Also, they can be used for data input.

Physical Environment

The physical environment in which the control system will be located. Consider the environment where the control system will be located. In harsh environments, house the control system in an appropriate IP-rated enclosure. Remember to consider accessibility for maintenance, troubleshooting or reprogramming.

6	With block diagram explain the functional requirements of industrial robot.	[10]	CO4	L2

The robot controller has two main units such as central processing unit and the operational unit. The central processing unit supplies output information using following input data.

- Instruction defining task to be carried out.
- Measurements concerning the state of the operational unit.
- Observations on the work space.

The central processing unit is concerned with data processing. The operational unit is the physical robot itself. It takes the action on the work space by using, transforming and/or acquiring energy form the suitable sources and reacting to the signals and commands provided by the sensory systems and central processing unit. The block diagram of the central processing unit has been shown in the Fig 3.15

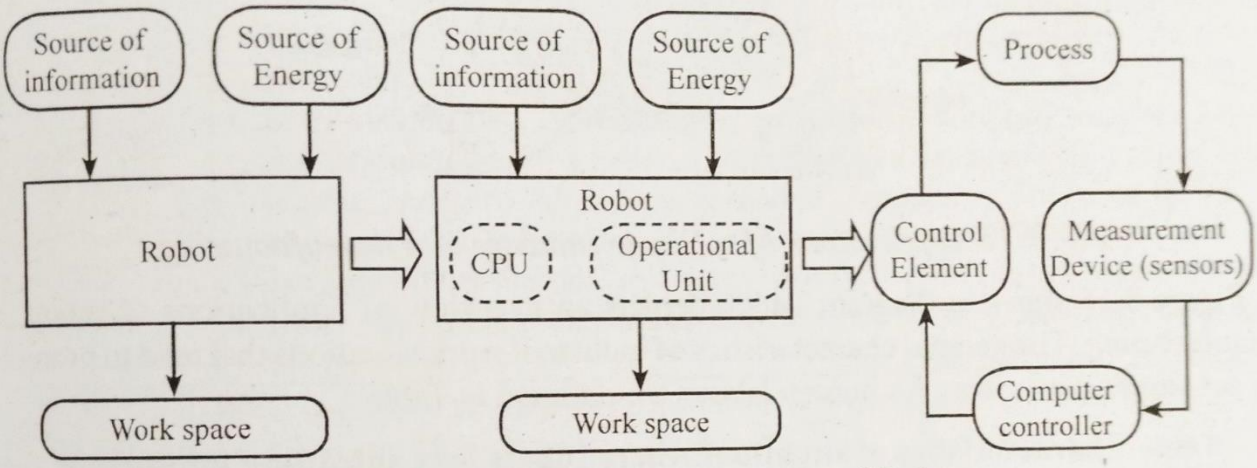


Fig. 3.15 Functional requirement of Robot

Robot can perform various tasks like handling and conveying objects, transformations, assembling of the objects, measuring, tele operation, etc.

The function of a robot is defined not only in terms of task but also in terms of its work space, for instance constraints imposed by its surrounding, characteristics of the objects involved in the task.

Next, the objects involved in each task should be characterized according to size, shape, weight, temperature, state of surface, internal composition, flexibility and so on. Thus the verity of tasks and working conditions determine the effective use of robot. The robot controller can also be realised by the use of microprocessor and microcontroller.

The microprocessor and microcontroller chips are can often be integrated to present a control level. This is when programmed controller operates upon the peripherals of the robot. We find such robots in applications such as industrial production line applications.

7	With neat diagram explain i) Ratchet and pawl mechanism. ii) Cylindrical cam.	[10]	CO4	L3

4.5 Ratchet and pawl mechanism

A ratchet is a device that allows linear or rotary motion in only one direction. Figure shows a schematic of the same. It is used in rotary machines to index air operated indexing tables. Ratchets consist of a gearwheel and a pivoting spring loaded pawl that engages the teeth. The teeth or the pawl, are at an angle so that when the teeth are moving in one direction the pawl slides in between the teeth. The spring forces the pawl back into the depression between the next teeth. The ratchet and pawl are not mechanically interlocked hence easy to set up. The table may over travel if the table is heavy when they are disengaged. Maintenance of this system is easy.

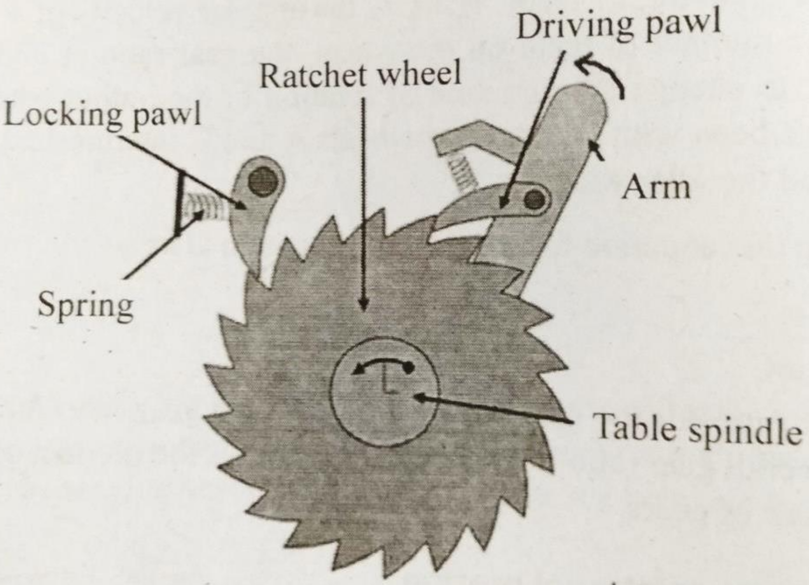


Fig. 4.12 Ratchet and pawl mechanism

c) Cylindrical cam

Here a cylinder has a circumferential contour cut in the surface and the cam rotates about its axis (Figure 4.3.4). The follower motion is either oscillating or reciprocating type. These cams are also called drum or barrel cams.

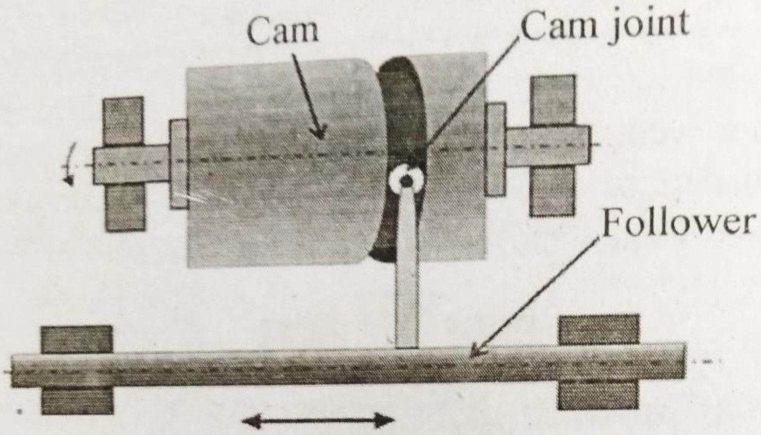


Fig 4.6 Cylindrical cam

8	Write short note on i) Gear train. ii) Mechanical aspects of motor selection.	[10]	CO4	L3

4.3.1 Gear trains

The term gear train is used to describe a series of intermeshed gear wheels. The term simple gear train is used for a system where each shaft carries only one gear wheel, as in figure 4.15. for such a gear train, the overall gear ration is the ratio of the angular velocities at the input and output shafts and is thus C, i.e.

$$\frac{\omega_A}{\omega_B} = G$$

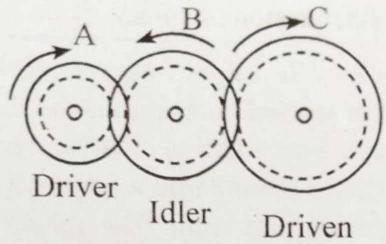


Fig. 4.10 Simple Gear train

Consider a simple gear train consisting of wheels A, B and C, as in Figure with A having 9 teeth and C having 27 teeth. Then, as the angular velocity of a wheel is inversely proportional to the number of teeth on the wheel, the gear ratio is 27/9=3. The effect of wheel B is purely to change the direction of rotation of the output wheel compared with what it would have been with just the two wheels A and C intermeshed. The intermediate wheel, B, is termed the idler wheel.

We can rewrite this equation for the overall gear ratio G as

$$G = \frac{\omega A}{\omega C} = \frac{\omega A}{\omega B} = \frac{\omega B}{\omega C}$$

But is the gear ratio for the first pair of gears and the gear ratio for the second pair of gears. Thus the overall gear ratio for a simple gear train is the product of the gear ratios for each successive pair of gears.

4.9 Mechanical aspects of motor selection

A motor drive system is mechanically required to rotate a shaft and its attached load. Factors that have to be considered are moments of inertia and torque.

4.9.1 Moments of inertia

The torque required to give a load with moment of inertia I_L an angular acceleration a is $I_L a$. The torque required to accelerate the motor shaft is $T_m = I_m a_m$ and that required to accelerate the load is $T_L = I_L a_L$. The motor shaft will, in the absence of gearing, have the same angular acceleration and same angular velocity. The power needed to accelerate the system as a whole is $T_m \omega + T_L \omega$, where ω is the angular velocities. Thus:

$$\text{power} = (I_M + I_L)\, a\, \omega$$

This power is produced by the motor torque and thus the power must equal to hence

$$T = (I_M + I_L)\, a$$

4.9.2 Torque

Figure shows the operating curves for a typical motor. For continuous running the stall torque value should not be exceeded. This is the maximum torque value at which overheating will not occur. For intermittent use, greater torques are possible. As the angular speed is increased so the ability of the motor to deliver torque diminishes. Thus if higher speeds and torques are required than given by a particular motor, a more powerful motor needs to be selected.

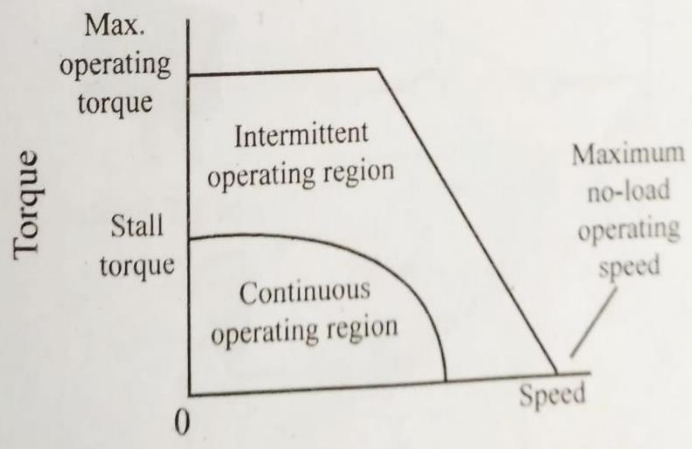


Fig. 4.17