Sinhgad Institutes

Sinhgad Technical Education Society's

Sinhgad Academy of Engineering, Kondhwa (Bk.), Pune

LAB MANUAL

System in Mechanical Engineering

[102003]

First Year Engineering

Semester - I

Academic Year: 2020-2021

Experiment No.1

Title of Experiment: Demonstration of power train system in the vehicle

Objectives: Study and demonstration of power train system in the vehicle.

Theory:

Power train system acts as a power transmission system from engine to wheels. The components involved in this transmission are :

i) Engine
ii) Flywheel
iii) Clutch
iv) Gear box
v) Universal joint
vi) Propeller shaft
vii) Differential gear box
viii) Wheels

i) Engine:

It is a device which converts chemical energy of fuel into heat energy and heat energy into mechanical energy. It is the first element in power transmission system of the vehicle. There are two types of engines i.e., Suction ignition engine and Compression ignition engine.

During the suction stroke the mixture of fuel and air is supplied and the mixture is ignited with the help of spark provided by spark plug before the end of compression stroke. These are called S.I. engines. However the working of diesel engine is similar to petrol engine except that in case of C.I. engines the air only drawn during its suction stroke instead of air fuel mixture. In case of C.I. engines the fuel is injected into the cylinder before the end of compression stroke under very high pressure.

ii) Flywheel:

Flywheel is mounted on the engine shaft. It serves a purpose of energy storage and eliminates the fluctuations in mechanical energy supply.

iii) Clutch:

Clutch is mounted on engine shaft and function of the clutch is to engage or disengage the engine shaft and gear box shaft. When clutch is in engage position, power from engine shaft is transmitted to gear box and when it is in disengage position, power transmission closed.

There are three types of clutches

1) **Plate clutches**

   The plate clutch consist of a set of driving plates and driven plates arranges alternatively. The plate clutch are most commonly used types of clutches in automobile. There are two types of plate clutches i.e., Single plate clutch and Multiplate clutch.

2) **Cone clutches**

   The cone clutch consist of a cup keyed to the driving shaft and a cone with friction lining free to slide axially on the splined driven shaft.

3) **Centrifugal clutches**

   The centrifugal clutch works on the principle of centrifugal force.

iv) Gear box:

Gear box receives the power from engine through clutch and transmits the power to the propeller shaft.

In automobile vehicle, the I.C. engine operates at high speed but the torque produced by engine is not very high. If I.C. engine is directly connected to the wheels, the engine torque may not be sufficient to drive the vehicle. The gear box receives the power from engine at high speed. It reduces the speed and increases the torque, which is adequate to drive the vehicle.

The function of gear box are :

i) Gear box reduces the speed and increases the torque.

ii) Gear box provides wide range of speeds and torque to the vehicle.

iii) With reverse gear, gear box provides the means to move the vehicle in reverse direction.

iv) In neutral position, the gear box disconnects the I.C. engine from the wheel even with the clutch in the engaged position.

v) Universal joint:

They provide for the relative movement between the engine and the driving wheels due to flexing of road springs. It connects the propeller shaft and transfer box shaft. Universal joint provides flexibility in position as well as axial movement of both connected shafts.

vi) Propeller shaft:

The power is transmitted from the gear box to the differential gear box through a long shaft called as Propeller shaft. The position of input shaft of differential gear box is at much lower level as compared to output shaft of the gear box.

The axes of two shafts are parallel but there is some offset. Therefore, to connect these two shafts through propeller shaft, universal joint is used at each end of the propeller shaft.

vii) Differential gear box:

Differential gear box transmits the power from the propeller shaft to the shaft of a rear axle.

The functions of differential gear box are :

i) The shaft of rear axle is at right angles to the propeller shaft. The differential gear box transmits the power at right angles.

ii) The differential gear box allows the two wheels to rotate at different speeds when vehicle is taking the turn.

iii) The differential gear box increases the torque and reduces the speed from propeller shaft to rear axle shaft.

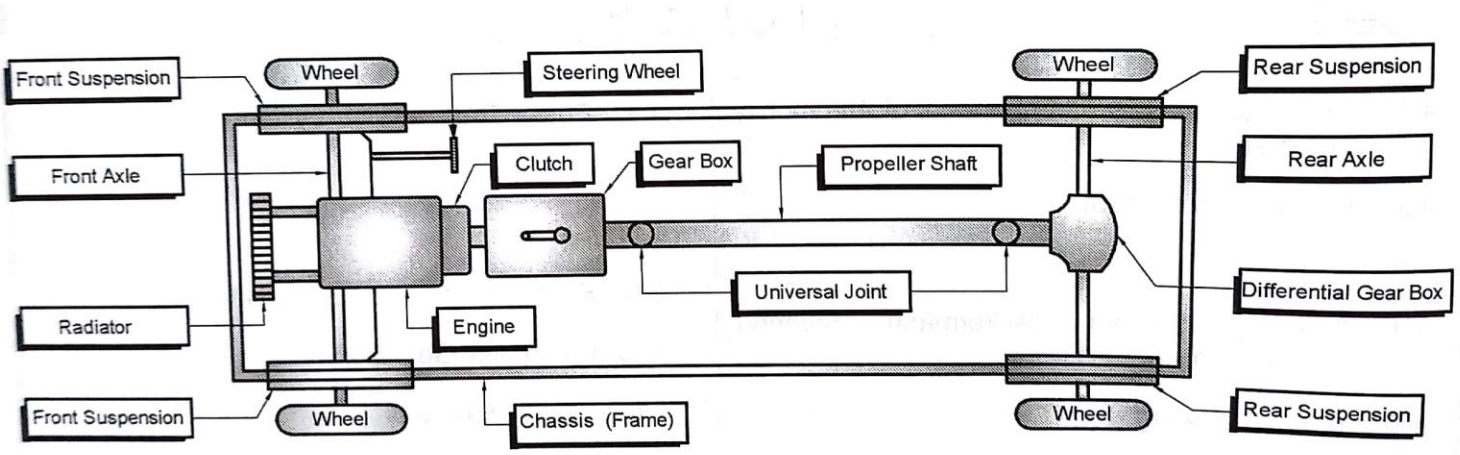


Figure 1: Power train system

Conclusion:

Experiment No. 2

Title of Experiment: Demonstration of vehicle systems (Automobile chassis, Steering system).

Objectives: Study and demonstration of vehicle systems (Automobile chassis, Steering system).

Theory:

A] Automobile chassis:

Various components of automobile chassis are:

i) Chassis (Frame)

ii) Axles

iii) Wheels

iv) Suspension system

v) Steering system

vi) Engine

vii) Clutch

viii) Gear box

ix) Propeller shaft and Universal joint

x) Differential gear box

xi) Radiator

i) Chassis (Frame):

Chassis is a skeleton frame of a vehicle on which various components of vehicle are mounted. It is the most important component of the vehicle.

ii) Axles:

Axles are the components on which chassis is mounted. The axles are supported between the wheels. Types of axles are –

Front axle: The front axle supports the chassis on front side. The steering mechanism is mounted on front axle.

Rear axle: The rear axle supports the chassis on rear side. The rear axle consist of driving shaft enclosed in tubular structure.

iii) Wheels:

Wheels supports the axle. The load of vehicle and passengers is supported by wheels through the axle.

iv) Suspension system:

Chassis is mounted on the axle not directly but through the suspension system. The suspension system isolates the vehicle body and passengers from road shocks.

v) Steering system:

Steering system is used for turning the wheels or vehicle in desired direction. It is mounted on front axle.

vi) Engine:

It is a device which converts chemical energy of fuel into heat energy and heat energy into mechanical energy. It is the first element in power transmission system of the vehicle. There are two types of engines i.e., Suction ignition engine and Compression ignition engine.

vii) Clutch:

Clutch is mounted on engine shaft and function of the clutch is to engage or disengage the engine shaft and gear box shaft. When clutch is in engage position, power from engine shaft is transmitted to gear box and when it is in disengage position, power transmission closed.

viii) Gear box:

Gear box receives the power from engine through clutch and transmits the power to the propeller shaft. In gear box, torque is increased and speed is reduced. Gear bos produces different speed ranges for the vehicle.

ix) Propeller shaft and Universal joint:

The power is transmitted from the gear box to the differential gear box through a long shaft called as Propeller shaft. The position of input shaft of differential gear box is at much lower level as compared to output shaft of the gear box.

The axes of two shafts are parallel but there is some offset. Therefore, to connect these two shafts through propeller shaft, universal joint is used at each end of the propeller shaft.

x) Differential gear box:

Differential gear box transmits the power from the propeller shaft to the shaft of a rear axle.

The functions of differential gear box are :

i) The shaft of rear axle is at right angles to the propeller shaft. The differential gear box transmits the power at right angles.

ii) The differential gear box allows the two wheels to rotate at different speeds when vehicle is taking the turn.

iii) The differential gear box increases the torque and reduces the speed from propeller shaft to rear axle shaft.

xi) Radiator:

Radiator is a heat exchanger placed at the front of the vehicle. It cools the hot coolant coming from the engine and sends it back to the engine.

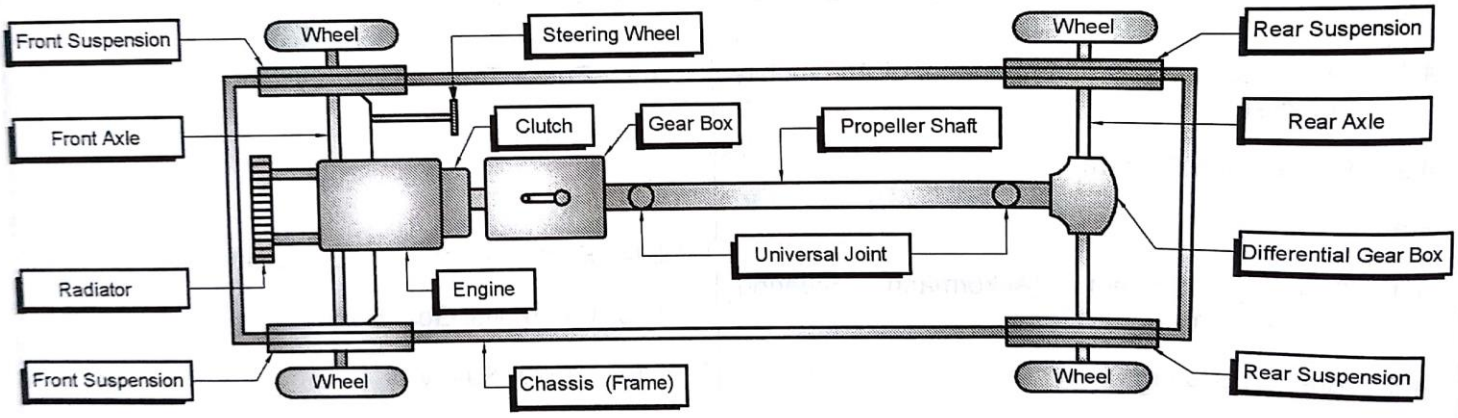


Figure 1: Layout of Chassis

B] Steering system (Ackermann steering mechanism):

Steering system is a mechanism used for converting the rotary motion of steering wheel into angular motion of front wheels to turn the vehicle in desired direction. The most commonly used steering mechanism is Ackermann steering mechanism.

Various components of steering systems are:

i) Axle beam

ii) Stub axle

iii) King pin (Swivel pin)

iv) Tie rod

v) Rack and pinion

vi) Steering column

vii) Steering wheel

i) Axle beam:

Vehicle chassis is supported on axle beam through the suspension system. Axle beam takes the weight of vehicle and transmit it to the stub axle.

ii) Stub axle:

Stub axles are pivoted at the two ends of the axle beam by king pins. One end of the stub axle carries the wheel and brake drum while other end of the stub axle is connected to the tie rod.

iii) King pin (Swivel pin):

King pin pivots the stub axle on axle beam.

iv) Tie rod:

Two stub axles are connected to each other by tie rod. With the help of adjuster, the length of tie rod can be adjusted. Tie rod is important part of steering system.

v) Rack and pinion:

In order to achieve the turn of the wheels, the stub axles need to oscillated about the king pin. The oscillatory motion of stub axles can be achieved by giving the linear motion to the tie rod. Rack mounted on the tie rod engages with pinion mounted on steering column.

vi) Steering column:

When steering column rotates, the pinion mounted on steering column also rotates. The rotary motion of pinion is converted into linear motion of rack and tie rod.

vii) Steering wheel:

Driver rotates steering wheel so as to rotate the steering column. The rotary motion of steering wheel is converted into angular motion of front wheels.

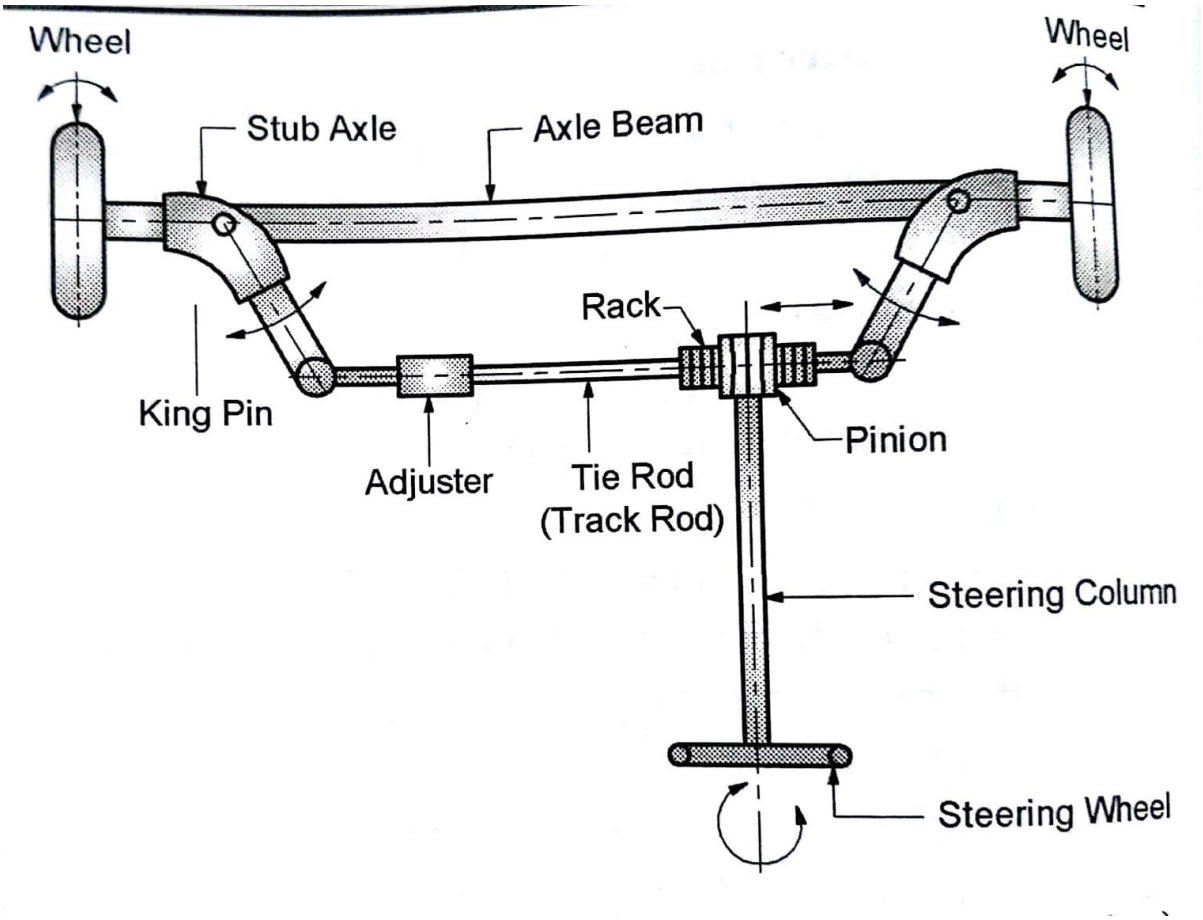


Figure 2: Steering system (Ackermann steering mechanism)

Conclusion:

Experiment No. 03

Aim : Demonstration of energy conversion devices.

Objective: To study demonstration of energy conversion devices like Centrifugal pump, Reciprocating air compressor, Pelton Turbine etc.

Theory:

1) Centrifugal Pump:

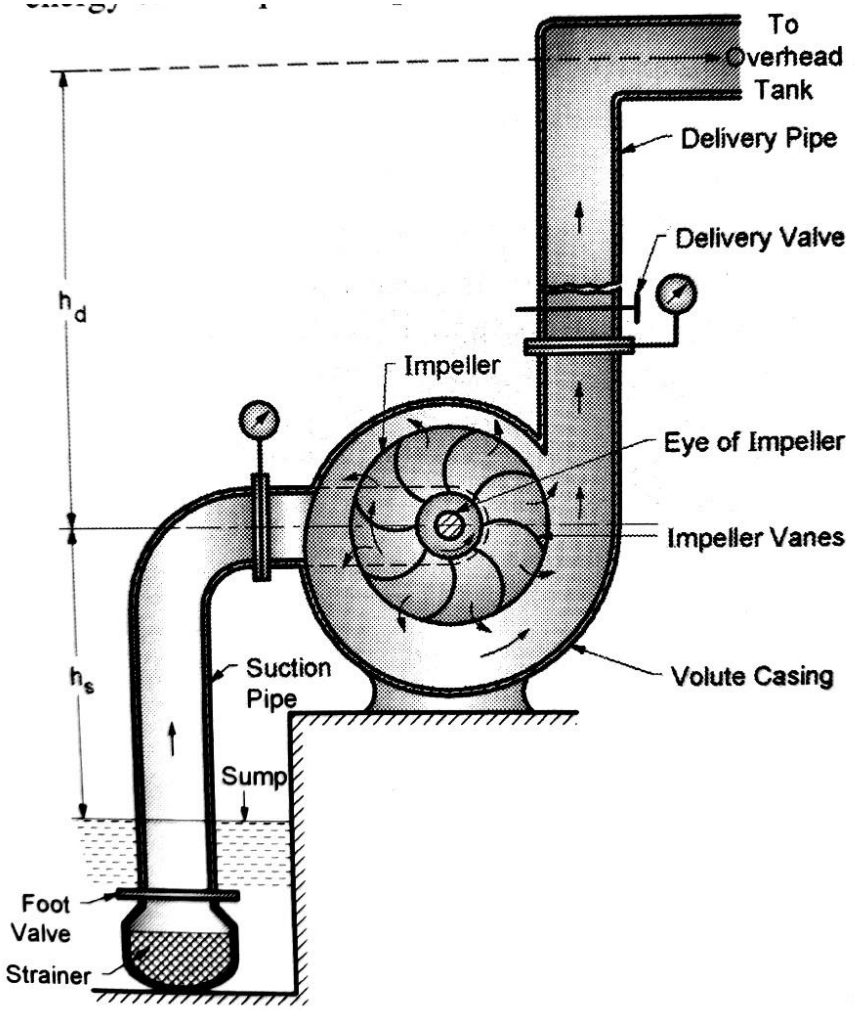


Figure: Centrifugal Pump

- **Construction of Centrifugal Pump**

A Centrifugal pump has following main components:

i) Impeller:

An impeller is a wheel or rotor having a series of backward vanes or blades. The impeller is mounted on a shaft which is usually coupled to a motor. The motor provides the required input energy to rotate the impeller.

ii) Casing:

The impeller is enclosed in a watertight casing with delivery pipe on one side and suction pipe on another side.

Casing has to perform two functions: (a) it guides the water from entry to exit of impeller, (b) it converts the kinetic energy of liquid into pressure energy.

iii) Suction pipe with strainer and foot valve:

The pipe which connects the sump to the eye of impeller is called suction pipe. The sump carries the liquid to be lifted by the pump. The suction pipe at its inlet is provided with a strainer and a foot valve. The function of strainer is to prevent the entry of dust into the pump. The foot valve is a non-return valve which allows the flow of water only in upward direction.

iv) Delivery Pipe:

The pipe which connects the outlet of pump to delivery point is called delivery pipe.

- **Working of Centrifugal Pump**

i) Firstly, the delivery valve is closed.

ii) The priming of the pump is carried out. Priming involves the filling of liquid in suction pipe and casing up to the level of delivery valve so that no air pockets are left in the system.

iii) The pump, shaft and impeller is now rotated with the help of prime mover, like electric motor. The rotation of impeller inside a casing full of liquid produces a forced vertex which is responsible in imparting the centrifugal head to the liquid. It creates a vaccum at the eye of impeller and causes liquid to rise into suction pipe from the sump.

iv) The speed of impeller should be sufficient to produce the centrifugal head such that it can initiate discharge from delivery pipe.

v) Now the delivery valve is opened and the liquid is lifted and discharged through the delivery pipe due to its high pressure.

2) Reciprocating Air Compressor:

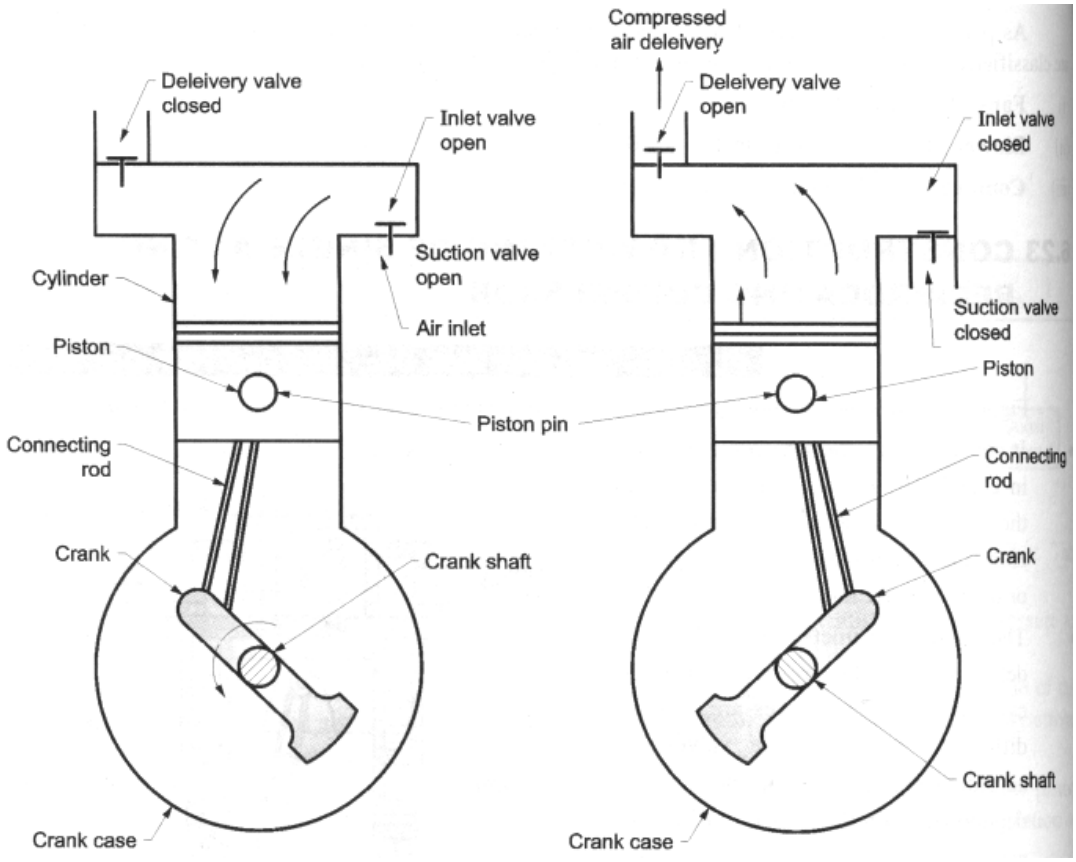


Figure: Reciprocating Air Compressor

- **Construction of Reciprocating Air Compressor**

i) It consist of piston which reciprocates in a cylinder. The piston is driven through the connecting rod and the crank. The crankshaft is driven by an electric motor.

ii) The suction valve and delivery valve are mounted on the cylinder head. The valves are automatically opened and closed depending upon the pressure difference across the valves.

iii) A flywheel is mounted on the crankshaft to ensure supply of uniform turning moment over the cycle. Water jacket is provided for cooling the air inside the cylinder.

- **Working of Reciprocating Air Compressor**

i) Suction Stroke:

- ✓ When the piston is moving downwards, the delivery valve is closed. The compressed air in clearance space of the previous stroke expands.
- ✓ When the pressure inside the cylinder falls below the atmospheric pressure, the inlet valve opens. The atmospheric air is sucked inside the cylinder up to the end of suction stroke.

ii) Compression Stroke:

- ✓ When the piston is moving upwards, the air sucked inside the cylinder during suction stroke is compressed gradually due to positive displacement of the piston. When the pressure becomes higher than atmospheric pressure, the inlet valve closes.
- ✓ With further movement of piston upwards, air pressure increases. When the pressure inside the cylinder reaches above the pressure on delivery side, the delivery valve opens. The compressed air from the cylinder is discharged to the receiver.

3) Pelton Wheel Turbine:

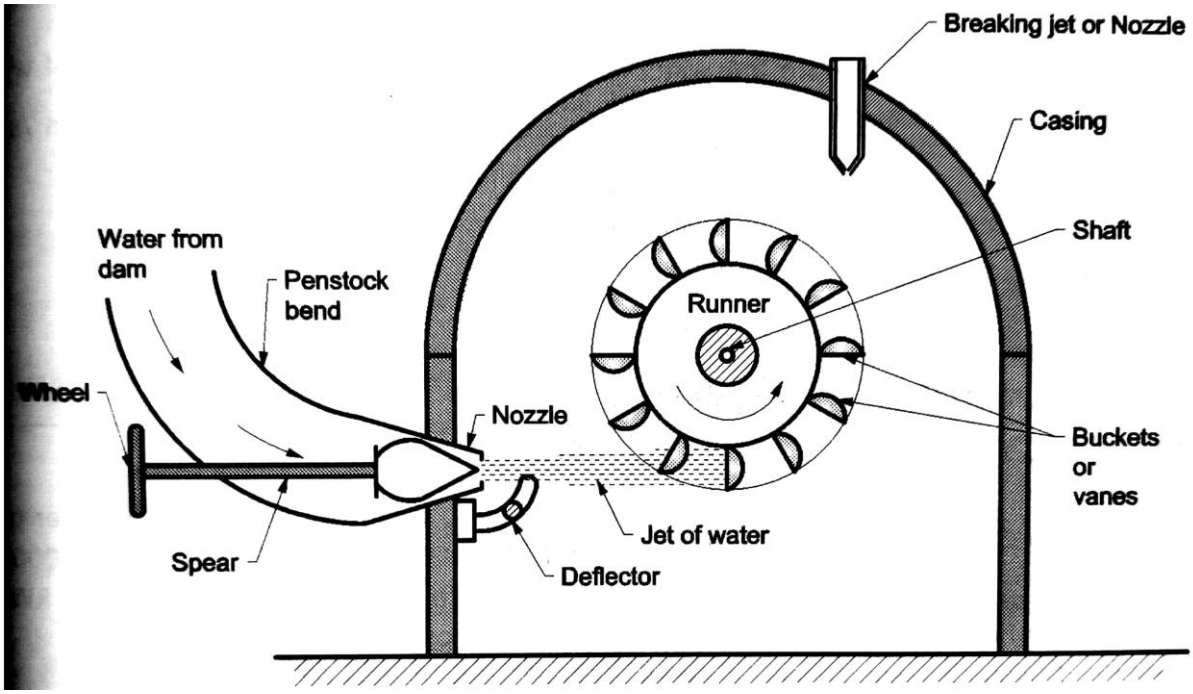


Figure: Pelton wheel turbine

- **Construction and Working of Pelton wheel turbine:**

i) The water from reservoir flows through the penstock to the nozzle which converts the pressure energy into kinetic energy.

ii) The resultant high velocity jet from nozzle strikes the buckets or vanes fitted at outer periphery of runner.

iii) The needle spear is provided in the nozzle to regulate the water flow through the nozzle.

iv) The axial movement of spear controls the quantity of water flow into the nozzles.

v) The runner is a circular disc fixed with double cup shaped buckets more than 15 in number which are mounted at equidistance around its periphery.

vi) The water at high velocity strikes the bucket at the splitter. It splits the water into two equal streams of the hemispherical bowl. Due to the impulse action, the rotor rotates in the direction of water jet and produces mechanical work.

vii) A casing is provided to prevent splashing of water and lead the water to tail race.

viii) In order to bring the turbine to rest, the nozzle is closed by the spear and through the braking nozzle the water jet is provided which falls on the back of buckets. It acts as hydraulic brake.

ix) Deflector is provided to deflect the jet of water away from striking the bucket in case the load on the turbine reduces.

Experiment No. 04

Aim : Demonstration of CNC.

Objective : Study and demonstration of Computer Numerical Control Machine.

Theory :

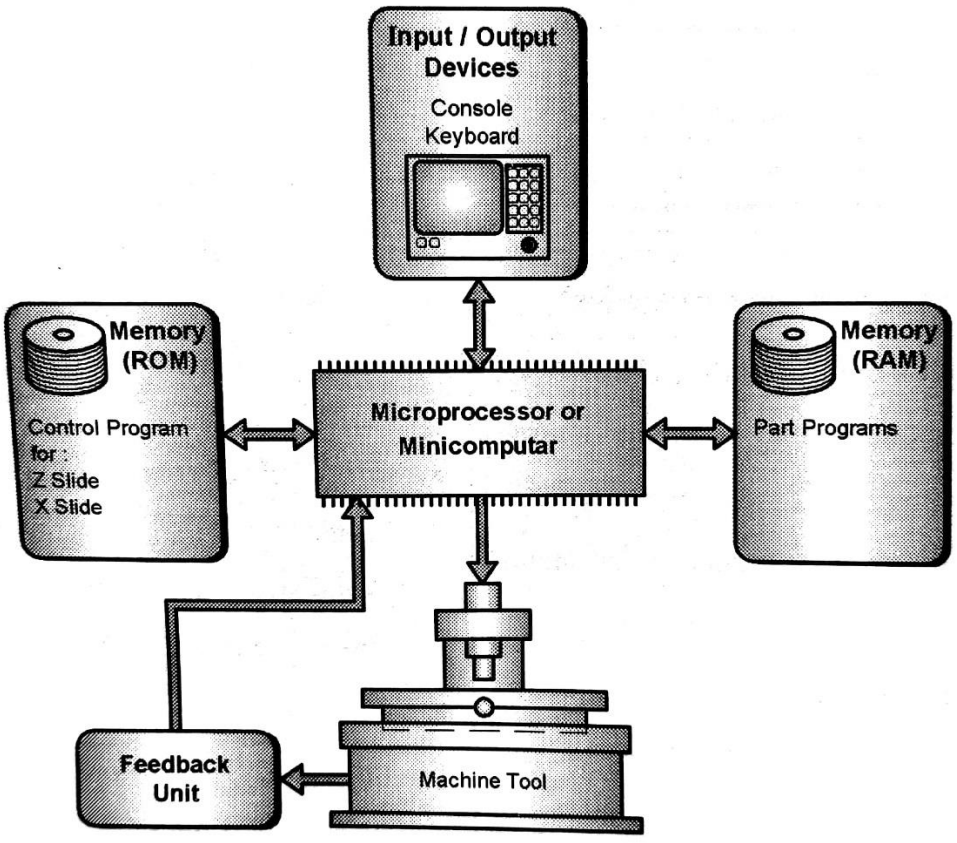
Introduction:

CNC machine are the machine tools of which various functions are controlled by a computer through a program fed to it, without human operator.

CNC is a machine which uses a dedicated computer as the machine controlled unit. In CNC machines, the entire program is entered and stored in computer memory. The machining cycle for each component is controlled by the program contained in computer memory.

The stored part program listing can be used for future production also.

Elements and Working of CNC Machine Tool:



Basic Elements of CNC machine tool system

The main elements of CNC machine tools are as follows:

1) Input/Output Devices:

The data is fed to CNC machine tool through keyboard.

2) Memory:

The memory consist of RAM and ROM. The memory stores programs and other machine tool control information.

3) Microprocessor or Minicomputer Based Control System:

Control system is like a brain of a CNC machine tool. It receives the data stored in the memory as part program. The data is converted into instructions to machine tool.

4) Machine Tool:

The machine tool is operated by the machine control unit. In CNC machine tools, the following functions may be automatic:

i) Starting and stopping of machine tool spindle.

ii) Controlling the spindle speed.

iii) Positioning the tool tip at the desired location and guiding it along the desired path.

iv) Controlling the feed rate.

v) Changing the tools.

5) Feedback Unit:

The feedback mechanism takes the feedback from machine tool and send it to microprocessor for corrective action.

6) Interfaces:

Interfaces provide the connections between microprocessor, machine tool and other elements.

Introduction to G – Codes and M – Codes:

1) G – Codes:

G – Codes are CNC programming language codes used by programmer to instruct CNC machine controller to perform various operations during machining process. Each G – code tells CNC machine controller to perform particular operation.

Example: G00 is a G – Code for fast too travel.

2) M – Codes:

M – Codes are CNC programming language codes used by programmer to instruct CNC machine controller to perform various miscellaneous functions. Each M – code tells CNC machine controller to perform particular miscellaneous function.

Example: M is M – code for stopping spindle rotation.

Advantages of CNC Machine Tools:

i) Using CNC machines complex components can be manufactured quickly and accurately.

ii) CNC machines produce components with high degree of accuracy.

iii) Because of uniform quality products, inspection time requirement is very less.

iv) The high accuracy of products eliminate most of the human errors, and hence, scrap and wastage is reduced.

v) The CNC machine produce components quickly with less setup and lead time. This increases the productivity.

Limitations of CNC Machine Tools:

i) The cost of CNC machines is several times more than the conventional machines because of sophisticated technology. Therefore, the initial investment in machines is high.

ii) The spares of CNC machines are costly. Therefore, the maintenance cost is high.

iii) CNC manufacturing requires highly skilled and trained personnel for looking after the part programming and machine operations. Hence, the operational cost of the CNC machines is high.

Applications of CNC Machine Tools:

CNC Turning center, CNC Drilling machine, CNC Milling machine, CNC Welding machine, CNC Die-casting machine, CNC Grinding machine, CNC Gear shaper etc.

Conclusion:

Assignment No. 1 [A]

1) Explain Thermal power plant with neat sketch.

2) State advantages and limitations of thermal power plant.

3) Explain Nuclear power plant with neat sketch.

4) State advantages and limitations of nuclear power plant.

5) The coal consumption in steam power plant is 100 tonnes per day having calorific value of 21000 KJ/kg. Average power output per day from plant is 5800 kw. Find the overall efficiency of steam power plant.

Assignment No. 1 [B]

1) Explain Geothermal power plant with neat sketch.

2) Explain hydroelectric power plant with neat sketch.

3) Explain Solar power plant with neat sketch.

4) Explain Wind power plant with neat sketch.

5) State advantages and limitations of hydroelectric power plant.

Assignment No. 02

1) Draw a neat sketch of four stroke I C Engine and Explain different components of I C Engine.

2) Write vehicle specification parameters of two wheelers. Also, write specification of any one two wheeler.

3) Write vehicle specification parameters for Light Motor Vehicles. Also, write specifications of any one Light Motor Vehicle.

4) Draw the layout of chassis of a vehicle and explain the various components of an automobile vehicle.

5) Explain Drum Brake and Disc Brake with neat sketch.

6) Explain Fuel supply and Fuel injection system in Petrol Engine with neat sketch.

Assignment No. 03

1) Explain Battery Electric Vehicle with block diagram.

2) Explain Series hybrid vehicle with block diagram.

3) Explain Parallel hybrid vehicle with block diagram.

4) Write specifications of electric motor and battery of Electric car.

5) State Advantages and Limitations of Battery Electric car.

6) State Advantages and Limitations of Hybrid electric Vehicles.

Assignment no. 4

Q.1 Explain with neat sketch, working of a refrigerator.

Q.2 Explain with neat sketch, working of an Air conditioner.

Q.3 Explain with neat sketch, working of a water cooler.

Q.4 Explain with neat sketch, working of a washing machine.

Q.5 Explain with neat sketch, Vapour compression refrigeration system.

Industry / Workshop / Showroom Visit