LAB MANUAL

BASICS OF MECHANICAL ENGINEERING

(ESC 202)

G.S. Mandal's

MAHARASHTRA INSTITUTE OF TECHNOLOGY, AURANGABAD

DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF LABORATORY: THERMAL ENGINEERING		
LABORATORY MANUAL		
CLASS: FIRST YEAR	**PART:** I	**COURSE CODE :**ESC 202
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Vision of Institute:

MIT aspires to be a leader in Techno-Managerial education at national level by developing students as technologically superior and ethically strong multidimensional personalities with a global mindset.

Mission of Institute:

We are committed to provide wholesome education in Technology and Management to enable aspiring students to utilize their fullest potential and become professionally competent and ethically strong by providing,

- Well qualified, experienced and Professionally trained faculty
- State-of-the-art infrastructural facilities and learning environment
- Conducive environment for research and development.
- Delight to all stakeholders.

Vision of Mechanical Engineering Department

To be a center of excellence in the field of Mechanical Engineering where the best of teaching, learning and research synergize and serve the society through innovation and excellence in teaching.

Mission of Mechanical Engineering Department

To provide world-class under-graduate and graduate education in Mechanical Engineering by imparting quality techno-managerial education and training to meet current and emerging needs of the industry and society at large.

Program Educational Objectives (PEOs):

PEO 1	Graduates will apply the tools and skills acquired during their undergraduate studies either in advanced studies or as employees in engineering industries.
PEO 2	Graduates of the program will have successful technical and professional career.
PEO 3	Graduates of the program will continue to learn to adopt constantly evolving technology.
PEO 4	Graduates will demonstrate sensitivity towards societal issues.

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CLASS: FIRST YEAR	**PART:** I	**COURSE CODE :**ESC 202
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Course Objectives:

1. To understand the working of different boilers.
2. To understand working of IC engines.
3. To understand working principle of refrigerator and air conditioner
4. To understand working principle of different machine tool.

Course Outcomes:

CO	Statement
CO 1	Define concepts of thermodynamics and manufacturing systems
CO 2	Explain laws of thermodynamics used for various engineering applications
CO 3	Utilize the principles of thermodynamics for solving the problems of thermal systems
CO 4	Interpret different machine tools and thermal machines
CO 5	Select various engineering materials based on the properties and desired applications
CO 6	Summarize manufacturing processes and power transmitting elements

Program Outcomes:

POs		Description
PO 1	**Engineering Knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis**	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design / Development of Solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO 4	**Conduct Investigations of Complex Problems**	Use research-based knowledge and search methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	**The Engineer and Society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and Sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and Team Work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective

		reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long Learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes:

PSO 1	Ability to design & analyze components & systems for mechanical performance
PSO 2	Ability to apply and solve the problems of heat power and thermal systems
PSO 3	Ability to solve real life problems with the exposure to manufacturing industries

Syllabus

Maharashtra Institute of Technology, Aurangabad
(An Autonomous Institute)

Faculty of Science & Technology
Syllabus of F. Y. B.Tech. Non-Circuit Branches (Semester I)

Course Code: ESC202 Course: Lab-II: Basic Mechanical Engineering Teaching Scheme: Practical: 02 Hrs/week	Credits: 0-0-1 End Semester Examination/Oral: 25 Marks
List of Practical	**Any 10 practical's to be conducted** 1. Study and demonstration of low-pressure boiler (anyone) 2. Study and demonstration of high-pressure boiler (anyone) 3. Study and demonstration of 2 stroke and 4 stroke petrol engine 4. Study and demonstration of 2 stroke and 4 stroke diesel engine 5. Study and demonstration of domestic refrigerator 6. Study and demonstration of window type air conditioner 7. Study and demonstration of Lathe machine 8. Study and demonstration of Milling machine 9. Study and demonstration of Shaper machine 10. Study and demonstration of Radial Drilling machine 11. Assignment on Unit I, II, IV and VI (*One assignment on each of these units comprising theoretical concepts and numerical. Application of Excel / MATLAB for numerical examples.*) / Presentation on technical case studies 12.Two MCQ Tests of 15 marks each based on course contents related to GATE Examination. **Assessment will be based on:-** 1. Attendance 2. Assignments 3. MCQ Test/Presentation on technical case studies 4. Viva-voce

Lab Instructions

1. Student should wear college ID-card and must carry record and observation.
2. Take signature of lab in charge after completion of observation and record.
3. If any equipment fails in the experiment report it to the supervisor immediately.
4. Students should come to the lab with thorough theoretical knowledge.
5. Don't touch the equipment without instructions from lab supervisor.
6. Don't crowd around the experiment and behave in-disciplinary.
7. Students should carry their own stationary and required things.
8. Using the mobile phone in the laboratory is strictly prohibited.

EXPERIMENT NO. 1

Aim: Study and demonstration of low pressure boiler (any one)

Objective: To understand the construction and working of low pressur boiler.

Apparataus: A model of Cochran boiler

Introduction

It is a multi-tubular vertical fire tube boiler having several horizontal fire tubes. This the modification of a simple vertical boiler where the heating surface has been increased by means of several fire tubes. This boiler is use in small plants requiring small quantities of steam and where the floor area is limited. The most common applications are steam rollers, pile drivers, steam shovels, portable hoisting rigs and certain other mobile applications.

Features and characteristics

Refer Fig. 1.1.The Cochran boiler is

- Vertical,
- Multi tubular,
- Fire tube,
- Internally fired and
- Natural circulation boiler.
- It is suitable for small plants requiring small quantities of steam and where the floor area is limited.
- These boilers are manufactured in 23 different sizes and are easily transportable. The shell diameter ranges from 0.9 m to a maximum of 2.75 m.

The following specifications are related to Cochran boiler having 2.75 m diameter shell:

- Height of the shell = 5.78 m
- Maximum evaporative capacity = 568 kg/h of steam from cold feed when burning 36 to 40 kg/h of coal.
- Economical rating = ¾ of the maximum
- Heating surface = 120 m^2

- Steam pressure = 6.7 bar

Construction and working

Cochran boiler, illustrated in Fig., provides an excellent example of the improved design of vertical, multi-tubular, internally fired natural circulation boiler.

The Cochran boiler essentially consists of:

(i) Boiler shell with hemispherical crown,

(ii) Furnace, fire box and grate,

(iii) Combustion chamber and flue pipes,

(iv) Smoke box and chimney; and

(v) Connections for boiler mounting and accessories,

The unit consists of a cylindrical shell with a dome shaped top where the space is provided for steam. The shell is formed of steel plates joined together with the rivets. Both the circumferential and longitudinal joints are lap joints made steam tight by fullering or caulking operation.

The fuel is burnt on grate in the furnace provided at the bottommost part of boiler. The furnace has no riveted seams exposed to flame and is pressed hydraulically from one plate to finished shape. This makes the furnace suitable to resist the intense heat produced by the combustion of fuel.

The grate consists of iron bars which are arranged with spacing between them. The spacing allows the air to pass onto the fuel for combustion.

The firebox is hemispherical so that the unburnt fuel, if any, is deflected back to the grate and complete combustion is achieved.

An ash pit is attached beneath the furnace for collecting ash after regular intervals. The boiler can be arranged to burn almost any kind of fuel including wood, paddy husk and oil fuel. For operation as an oil-fired unit, an oil burner is fitted at the fire hole. The grate is then dispensed with a lining of fire brick is provided beneath the furnace.

The coal, on burning, produces hot flue gases and these hot products of combustion from the fire box enter through the small flue pipe into the combustion chamber which is lined with fire bricks on the outer wall of the boiler. The lining prevents the shell from being damaged due to the overheating.

The dome shaped furnace and the combustion chamber prevent the loss which could otherwise occur because of combustion being retarded and much unburnt and combustible matter leaving the furnace.

The unburnt fuel is deflected back to the grate and complete combustion, is achieved in combustion chamber where the high temperatures are maintained.

The hot gases passing through the horizontal smoke tubes give their heat to the water and in doing so convert water into steam which gets accumulated in the upper portion of the shell from where it can be supplied to the user. The flue tubes are generally of 62.5 mm external diameter and are 165 in number. The crown of the shell is made hemispherical in shape which gives the maximum space and strength for a certain weight of material in form of plates.

Finally, the flue gases are discharged to the atmosphere through the smoke box and the chimney. The smoke box door enables the cleaning and inspection of the smoke box and fire tubes. Through a manhole provided at the crown of the shell, a man can enter the boiler for periodic cleaning and maintenance of the boiler. There are connections provided at appropriate places for fixing the usual boiler mounting such as pressure gauge, water level indicator, safety valve, steam stop valve, feed check valve and blow off cock etc.

The following mountings are fitted to boiler

Pressure gauge: this indicates the pressure of the steam inside the boiler. **Water gauge**: this indicates the water level in the boiler. The water level in the boiler should not fall below a level, otherwise the boiler will be over heated and the tubes may burn out. **Safety valve**: the function of the safety valve is to prevent an increase of steam pressure in the boiler above its normal working pressure.

Steam stop valve: it regulates the flow of steam supply to requirements.

Blow-off cock: it is located at the bottom of the boiler. When the blow-off cock is opened during the running of the boiler, the high-pressure steam pushes (drains) out the impurities like mud, sand, etc., in the water collected at the bottom.

Fusible plug: it protects the fire tubes from burning when the water level in the boiler falls abnormally low.

Salient features of Cochran boiler:

The dome shape of the furnace causes the hot gases to deflect back and pass through the flue. The un-burnt fuel if any will also be deflected back.

1. Spherical shape of the top of the shell and the fire box gives higher area by volume ratio.
2. It occupies comparatively less floor area and is very compact.
3. It is well suited for small capacity requirements.

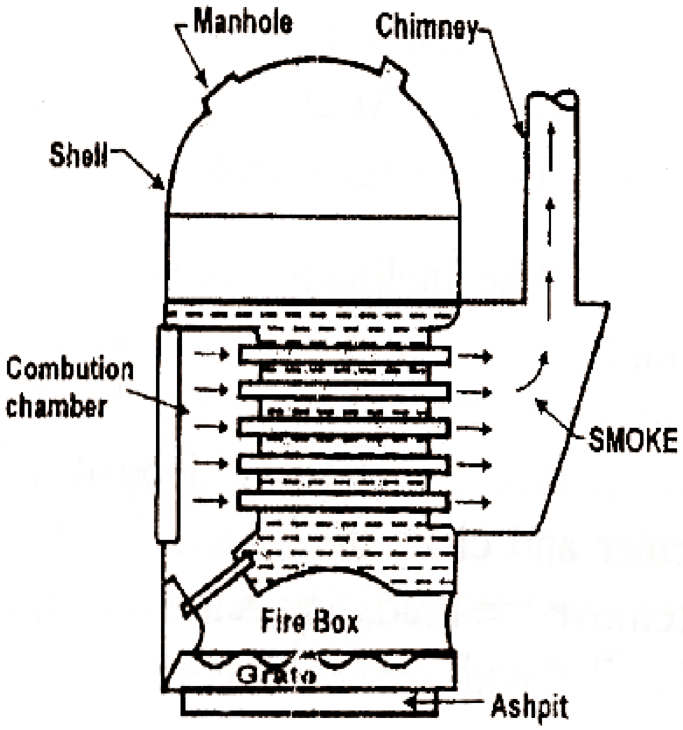

Figure 1.1: Cochran boiler

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following Questions

a) Cochran boiler is a …………………….Tube boiler.

b) Enlist salient features of Cochran Boiler.

c) Enlist any five important parts of Cochran boiler.

d) What is the function of Smoke box in Cochran boiler?

e) The following is a mounting of a boiler.

- Pressure gauge
- Preheater
- Economiser
- Super-heater

EXPERIMENT NO. 2

Aim: – Study and demonstration of high pressure boiler (any one)

Objective: To understand the construction and working of high pressur boiler.

Apparataus: A model of Babcock and Wilcox boiler

Introduction

This is a horizontal, externally fired, water tube, natural circulation type stationary boiler. This boiler is the most common type used in thermal power plants for generation of steam in large quantities. It consists of a high-pressure steel drum mounted at the top as shown in fig.2. From each end of the drum, connections are made with the uptake header and a down take header. The headers are joined to each other by many water tubes which are kept inclined at an angle of about 15 degree to the horizontal. The water tubes are straight, solid drawn steel tubes about 10 cm in diameter and are expanded into the bored holes of the headers.

The furnace is located below the uptake header. The coal is fed to the chain grate stoker through the fire door baffles are provided across the water tubes to act as deflectors to the flue gases. The hot gases rise upwards, go down and then rise again and finally escape to chimney through the smoke chamber. To maintain a uniform velocity of flue gases throughout their travel, the passage of the gases is decreased from furnace to exit.

The circulation of water is maintained by convective currents. The cold-water flows from the drum to the rear header and thus cycle are repeated. For getting superheated steam, the steam accumulated in the steam space is sent to the superheated tubes which are arranged above the water tubes. The super-heated steam is finally supplied through a steam stop valve and steam pipe. Evaporative capacity of such boiler rages from 20, 000 to 40,000 kg/hour and operating pressures of 11.5 to 17.5 bar are quite common.

Features and characteristics

- This boiler is
    - A stationary
    - Longitudinal drum,

- Externally fired,
- Natural circulation,
- Water tube boiler.
- It is suitable for all types of fuels.
- Evaporative capacity in this boiler ranges from 20,000 to 40,000 kg/h.
- Operating pressures ranges from 11.5 to 17.5 bars. But the operating pressures may be as high as 42 bars.

Constructional details of Babcock &Wilcox boiler.

Babcock and Wilcox have following parts: -

1. A horizontal steam & water drum: -

This is main part of boiler. It is supported by steel structure at certain height & is independent of brick works. The size of the boiler drum is small as compared to boiler drum of fire tube boiler of same capacity. It contains water & steam. All safety & control devices are mounted over the boiler drum.

2. **A bundle of steel tubes**: -

The front end of the boiler drum connected to the uptake header by short tube &rear end is connected to down take header by along tube. In between the header, a no. Of small diameter steel tubes are fitted at an angle 5^o degree to 15 degree with horizontal to promote the water circulation. The steel tubes are arranged in combustion chamber in zig zag manner so that more surface area of the tube is exposed to hot gas.

3. Combustion chamber: -

It is a space above the grate below the front end of the drum where combustion of fuel takes. This combustion is enclosed by brick works & it is lined from inside by fire bricks & door are provided to give access of cleaning, inspection & repair purpose. Combustion chamber is divided into three separate compartments by baffled. This makes the longer path of hot gases before leaving the boiler through the chimney. Dampers provided at rear end of chamber to regulate the fresh air supply for maintaining proper combustion of fuel.

4. Safety & control device: -

Safety & control device are called mountings because basically these devices are mounted over the boiler drum. These are safety valve, pressure gauge, water level indicator, feed check valve, steam valve, blown off cock, fusible plug, and man hole.

Working

(i) Path of Flue gas: The hot gases from the furnace first rise upwards and then go down and then rise again outside the water tube before it finally come out in the atmosphere through the chimney. The flow path of hot gases is shown by the arrows outside the tubes. During their travel, they give heat to water and steam is formed.

(ii) Path of steam-water circulation: Feed water is supplied into the drum by a feed water inlet pipe. As the water in the water tube near the uptake header meets the hot gases at higher temperature, that portion of water gets evaporated. Thus, the mixture of hot water and steam from this portion of the tube rises in the uptake header and then arrives in the steam water drum. In the steam drum, the steam vapors escape the water surface and collected in the upper half of the drum. On other hand, the cold-water flows from the drum to the water tubes through the down-take header. Thus, a continuous natural cycle of water in boiler is completed.

(iii) Super-heater arrangement: When superheated steam is desired to be produced, the steam accumulated in the steam space in the drum can enter the super heater tubes via anti-priming pipe. The flue gases passing over the super-heater tubes produce superheated steam. The superheated steam from super heater tube is then finally supplied to the work generating device through a steam stop valve.

(iv) Draft system: The supply of air to the grate is usually done naturally with the help of a chimney.

Salient Aspects:

1. Draught loss is minimum.

2. The replacement of the defective tubes can be made readily.

3. The unit has a capability to quickly cope with high peak loads which are generally needed at thermal power stations.

4. Inspection can be carried out even when in operation.

Uses

As it is suitable for small size thermal power plants, it may be used for stationary or marine purposes.

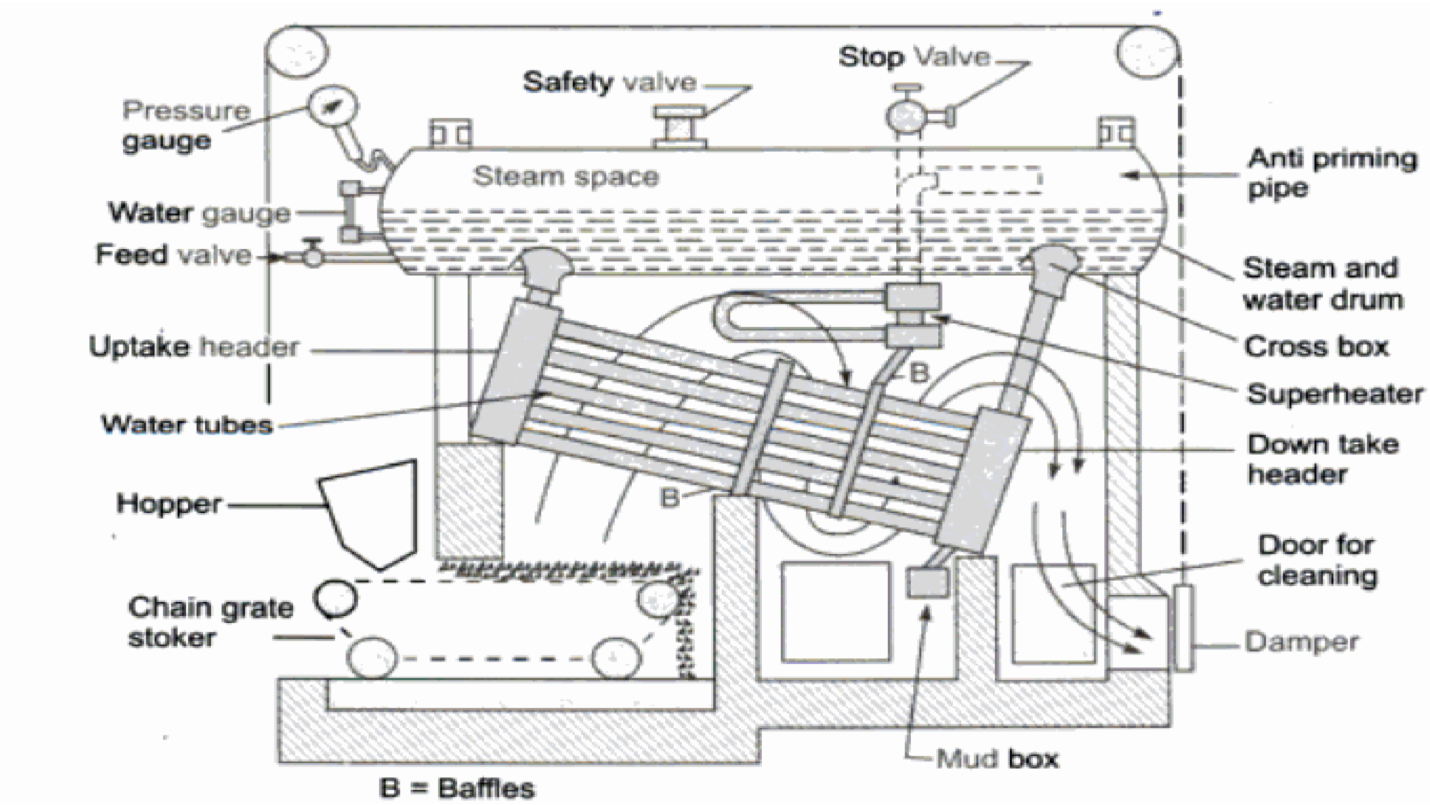

Fig: Babcock &Wilcox boiler

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following Questions

a) The following is an accessory of a boiler.

- Pressure gauge
- Safety valve
- Fusible plug
- Super-heater

b) Babcock &Wilcox boiler is ___________________Tube Boiler

c) Enlist any five important parts of Babcock &Wilcox boiler.

d) Why water-tube of Babcock &Wilcox boiler is designed in inclined to Horizontal?

e) How flue gas flows in the boiler?

EXPERIMENT NO. 3

Aim: Study and demonstration of 2 stroke and 4 stroke petrol engine

Objective: To understand the construction and working principle of SI engine

Apparataus: Models of IC engine.

Introduction

Heat engine is a machine for converting heat, developed by burning fuel into useful work. It can be said that heat engine is equipment which generates thermal energy and transforms it into mechanical energy.

Constructional Details of Petrol [SI] Engine.

Constructional details of Four stroke and two stroke SI engine are shown in figure 3.1 and 3.2 respectively.

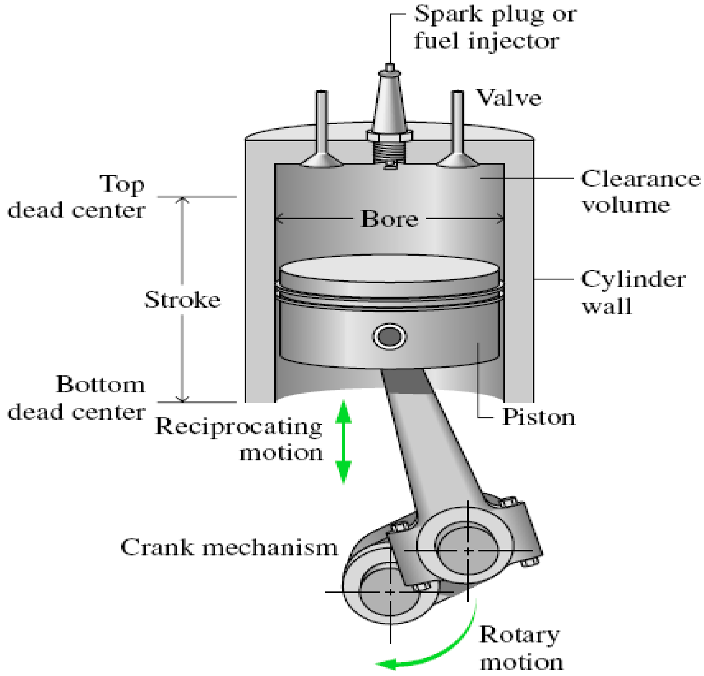

Figure 3.1: Four Stroke Petrol Engine

1. Cylinder: It is a cylindrical block having cylindrical space inside for piston to make reciprocating motion. Upper portion of cylinder which covers it from the top is called cylinder head. This is manufactured by casting process and materials used are cast iron or alloy steel.

2. Piston and Piston rings: Piston is a cylindrical part which reciprocates inside the cylinder and is used for doing work and getting work. Piston has piston rings tightly fitted in groove around piston and provide a tight seal to prevent leakage across piston and cylinder wall during piston's reciprocating motion. Pistons are manufactured by casting or forging process. Pistons are made of cast iron, aluminum alloy. Piston rings are made of silicon, cast iron, steel alloy by casting process.

3. Combustion space: It is the space available between the cylinder head and top of piston when piston is at farthest position from crankshaft (TDC).

4. Intake manifold: It is the passage/duct connecting intake system to the inlet valve upon cylinder. Through intake manifold the air/air-fuel mixture goes into cylinder.

5. Exhaust manifold: It is the passage/duct connecting exhaust system to the exhaust valve upon cylinder. Through exhaust manifold burnt gases go out of cylinder.

6. Valves [Only for Four Stroke Engine]: Engine has both intake and exhaust type of valves which are operated by valve operating mechanism comprising of cam, camshaft, follower, valve rod, rocker arm, valve spring etc. Valves are generally of spring loaded type and made from special alloy steels by forging process.

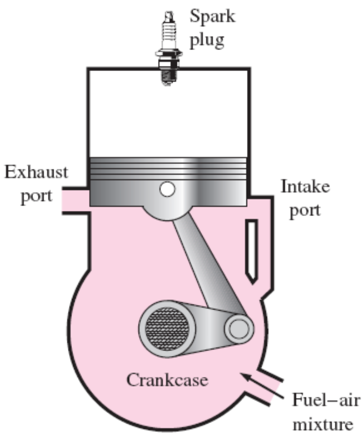

Figure 3.2: Two Stroke Petrol Engine

*****Figure shows the line diagram of 2-stroke SI engine. General Constructional arrangement shows that here there are no valves as in case of 4-stroke engines, instead it has exhaust and suction ports. Piston has a projection on its top, which acts like deflector. Mixture of air-fuel goes into crank case first and then gets transferred to top of piston at appropriate time. Here the burnt exhaust gases are forced out through the exhaust port by a fresh charge of fuel which enters the cylinder nearly at the end of working stroke through inlet port. This process is called as "Scavenging".*

7. Spark plug: It is the external ignitor used for initiating combustion process. Spark plug is activated by electrical energy fed by electrical system with engine. It delivers spark with suitable energy to initiate combustion at appropriate time for suitable duration.

8. Bearing: Bearings are required to support crank shaft. Bearings are made of white metal leaded bronze.

9. Connecting rod: It is the member connecting piston and crankshaft. It has generally I section and is made of steel by forging process.

10. Crank: It is the rigid member connecting the crankshaft and connecting rod. Crank is mounted on crankshaft. Crank transfers motion from connecting rod to crankshaft as it is linked to connecting rod through crank pin.

11. Crankshaft: It is the shaft at which useful positive work is available from the piston-cylinder arrangement. Reciprocating motion of piston gets converted into rotary motion of crankshaft. Crankshaft are manufactured by forging process from alloy steel.

12. Crankcase: Crankcase acts like an oil sump **[Only for Four Stroke Engine]** housing crank, crankshaft, connecting rod and is attached to cylinder. These are made of aluminum alloy, steel, cast iron etc. by casting process.

****In two stroke Petrol Engine Air Fuel mixture [Oil is also mixed with Petrol] enters the Crank Case from Inlet port and then this mixture transfer to the combustion chamber during expansion and Exhaust Stroke*

13. Gudgeon pin: It is the pin joining small end of the connecting rod and piston. This is made of steel by forging process.

14. Cams and Camshafts: Cams are mounted upon camshaft for opening and closing the valves at right timings and for correct duration. Camshaft gets motion from crankshaft through timing gears.

15. Carburetor: Carburetor is device to prepare the air fuel mixture in right proportion and supply at right time.

16. Bore: It is nominal inner diameter of the cylinder.

17. Piston area: It is the area of a circle of diameter equal to bore.

18. Stroke: It is the nominal distance travelled by the piston between two extreme positions in the cylinder.

19. Dead center: It refers to the extreme end positions inside the cylinder at which piston reverses its motion. Thus, there are two dead centers in cylinder, called as 'top dead center' or 'inner dead center' and 'bottom dead center' or 'outer dead center'.

Top dead center (TDC) is the farthest position of piston from crankshaft. It is also called inner dead center (IDC).

Bottom dead center (BDC) refers to the closed position of piston from crankshaft. It is also called outer dead center (ODC).

20. Swept volume: It is the volume swept by piston while travelling from one dead center to the other. It may also be called stroke volume or displacement volume. Mathematically, Swept volume = Piston area × Stroke

21. Clearance volume: It is the volume space above the piston inside cylinder, when piston is at top dead center. It is provided for cushioning considerations and depends, largely upon compression ratio.

22. Compression ratio: It is the ratio of the total cylinder volume when piston is at BDC to the clearance volume.

Working of 4-stroke SI (petrol) engine

Spark ignition (SI) engines employ external ignition system for initiating the combustion process. Spark plug is the most commonly used ignition method used in spark ignition engines. Working of engine is shown in figure 3.4.

Suction Stroke:

Let us start with piston at TDC. As piston moves for TDC to BDC, the inlet valve gets opened and fresh air-fuel mixture prepared in carburetor enters the cylinder. This supply of air-fuel mixture into cylinder is called suction process or suction stroke during which inlet valve is open while exhaust valve remains closed.

Compression stroke

After the piston reaches BDC, it reverses its motion and moves towards TDC. During this piston travel both inlet and exhaust valves remain closed. Thus, the air-fuel mixture inside cylinder gets compressed till piston reaches TDC. This is the second stroke and called compression stroke or compression process.

Power and Expansion Stroke:

Now highly compressed air-fuel mixture is available inside the cylinder and ready for combustion. With piston at TDC, the spark plug is activated and it releases spark for igniting air-fuel mixture. Spark plug used in the SI engines gets activated by suitable mechanism in the engine and provides suitable amount of energy in the form of spark for initiating combustion process. This burning of mixture is accompanied by sudden increase in pressure and temperature while piston passes the TDC position. Here constant volume heat addition takes place. Due to this release of fuel energy, the combustion products try to expand and piston moves from TDC to BDC. During this travel the inlet and exhaust valves remain closed. This stroke is called expansion stroke or power stroke or expansion process. This is the stroke accompanied by positive work available at shaft. Now while piston is at BDC the exhaust valve gets opened and combustion products are exhausted out.

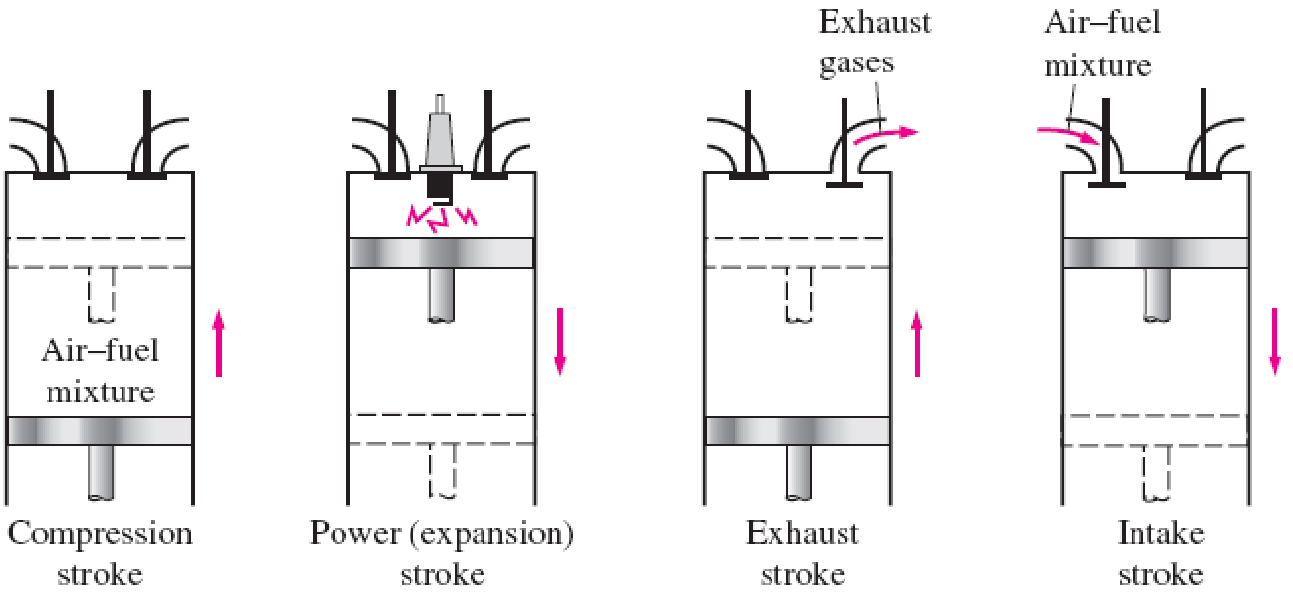

Figure 3.4: Working of four stroke SI Engine

Exhaust Stroke:

Cylinder is further emptied and made ready for being recharged while piston travels from BDC to TDC, pushing out burnt gases. This is called exhaust stroke.

Here, out of suction, compression, expansion and exhaust strokes only expansion stroke is accompanied by the production of positive work, rest three strokes are work absorbing strokes. Work requirement for the three strokes is met from the work available during expansion stroke. For storing the excess energy and releasing it when required, a flywheel is mounted over the crank shaft Cycle gets completed in two revolutions of crankshaft.

Examples of four stroke engines are petrol engines used in cars

Working of 2-stroke si engine

2-stroke SI engine is a modified form of 4-stroke engine where all the four processes required for completion of one cycle of SI engine get completed in two strokes. Thus, obviously in each stroke two processes get completed.

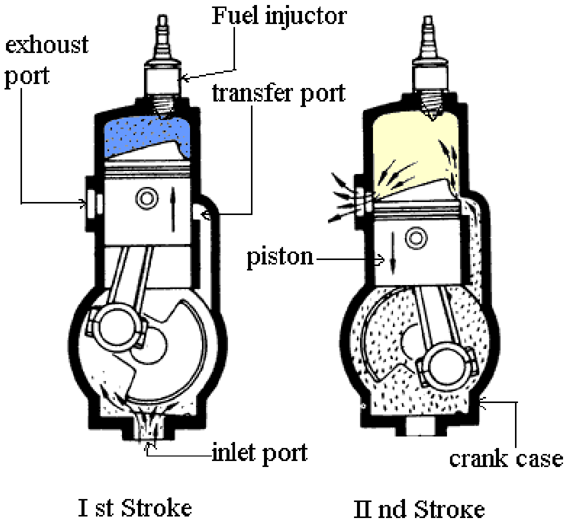

Figure 3.4: Working of two stroke SI Engine

Let us start piston movement from TDC to BDC. When piston reverses its motion from BDC to TDC then the suction port gets uncovered and fresh mixture enters and goes into crank case.

With piston moving from TDC to BDC and during covered position of suction port the mixture gets transferred to the top of piston through transfer port.

Expansion and exhaust stroke

Upon reversal during piston travelling from BDC to TDC, the air fuel mixture on top of piston gets compressed and subsequently gets ignited by spark from spark plug. The combustion of fuel-air mixture results in release of excessive energy which forces piston to move from TDC to BDC.

Simultaneously as piston uncovers exhaust port the burnt gases go out through exhaust port. Again, when piston reaches BDC it reverses its motion and during travel from BDC to TDC the suction takes place as explained above at the bottom of piston while compression of fuel air mixture takes place on top of piston.

Thus, suction and compression, both processes get completed during travel of piston from BDC to TDC. Expansion and exhaust processes occur during travel of piston from TDC to BDC along with transfer of fresh fuel air mixture from crankcase to top of piston.

Here all four processes occur during two strokes and one revolution of crank shaft. Thermodynamic cycle followed by 2-stroke SI engine is Otto cycle.

Scooter engines are generally two stroke engines. 2-stroke SI engines are used for smaller applications.

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following questions

a) In Four stroke engine one cycle is completed in _____________revolution of crankshaft
b) In two stroke engine power is generated after _____________stroke
c) Enlist the process of four stroke engine sequentially
d) What is the function of Spark plug in SI Engines?
e) Define the following terms

   i)Clearance volume ii)Swept volume iii)Compression ratio

EXPERIMENT NO.4

Aim: Study and demonstration of 2 stroke and 4 stroke diesel engine

Objective: To understand the construction and working principle of CI engine

Apparataus: Models of IC engine.

Introduction

Heat engine is a machine for converting heat, developed by burning fuel into useful work. It can be said that heat engine is equipment which generates thermal energy and transforms it into mechanical energy

Constructional Details of Diesel [C I] Engine.

Construction of Diesel Engine is mostly [Principally] like Petrol Engine, except the Spark plug in petrol engine is replaced by Fuel pump and Fuel Injector and this engine works at the higher-pressure ratio.

Fuel pump and Fuel Injector

An injection pump is the device that pumps diesel (as the fuel) into the cylinders of a diesel engine. Traditionally, the injection pump is driven indirectly from the crankshaft by gears, chains or a toothed belt (often the timing belt) that also drives the camshaft. It rotates at half crankshaft speed in a conventional four-stroke diesel engine. Its timing is such that the fuel is injected only very slightly before top dead center of that cylinder's compression stroke. It is also common for the pump belt on gasoline engines to be driven directly from the camshaft. In some systems injection pressures, can be as high as 200 MPa

Working of 4-Stroke CI (Diesel) Engine

Compression ignition (CI) engines operate generally on "Diesel"/ "Dual" cycle. In these engines, the combustion is realized due to excessive compression and are so called compression ignition engines.

Here air alone is sucked inside the cylinder during suction stoke and compressed. Degree of compression is much more than that of spark ignition (SI) engines.

After compression of air the fuel is injected into the high pressure and high temperature compressed air. Due to high temperature of air the combustion of fuel gets set on its' own. Self-ignition of fuel takes place due to temperature of air-fuel mixture being higher than self-ignition temperature of fuel. Thus, in CI engines, larger amount of compression causes high temperature, therefore unassisted combustion.

Schematic of 4-stroke CI engine is quite like that of 4-stroke SI engine with the only major difference that spark plug is replaced by fuel injector for injecting fuel at high pressure into compressed air.

4-Stroke CI engine works with following four processes getting completed in separate strokes. General arrangement in CI engine is like that of SI engine with spark plug replaced by fuel injector.

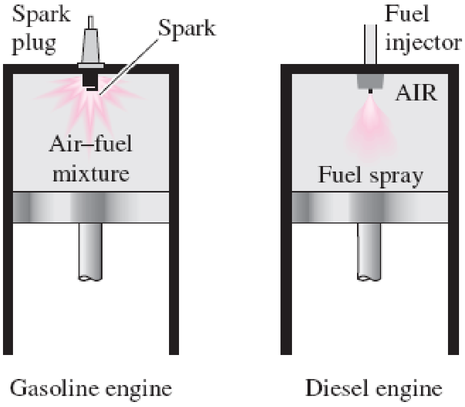

Figure 4.1: Shows difference between Petrol and Diesel Engine at the Begainning of Power Stroke

Suction Stroke:

Piston travels from TDC to BDC and air is sucked.

Compression stroke

Piston travels from BDC to TDC, while air is compressed with inlet and exit passages closed.

Power and Expansion Stroke:

Piston reaches TDC and air gets compressed. Fuel injector injects fuel into compressed air for certain duration. Ignition of fuel also takes place simultaneously as air temperature is much higher than self-ignition temperature of fuel. Burning of fuel results in release of fuel chemical energy, which forces piston to travel from TDC to BDC.

Contrary to SI engine where heat addition gets completed near instantaneously, in CI engines fuel injection and thus heat addition is spread in certain stroke travel of piston i.e. heat addition takes place at constant pressure during which piston travels certain stroke length as decided by cut-off ratio. This is expansion process and piston comes down to BDC with both inlet and exit valves closed.

Exhaust Stroke:

After expansion piston reverses its motion upon reaching BDC and travels up to TDC with exit passage open. During this piston travel burnt gases are expelled out of cylinder i.e. exhaust stroke. Completion of above four stroke requires two revolutions of crankshaft.

Working of 2-Stroke Diesel [Ci] Engine

Figure 4.2 shows the general arrangement in 2-stroke CI engine. Here the structure of CI engine is very much like that of SI engine with the major difference that spark plug is replaced by fuel injector, structure is made more sturdy to withstand high compression ratio.

Working of 2-stroke compression ignition engine is shown in (*a*), (*b*), (*c*), (*d*) explaining the suction, compression, expansion and exhaust processes.

Suction and compression stroke

During piston travel from BDC to TDC air enters crankcase. When piston reaches TDC and reverses its motion to BDC air in crankcase gets partly compressed and is transferred from crankcase to top of piston through transfer port.

Expansion and exhaust stroke

Upon reversal of piston motion from BDC to TDC the compression of air occurs by the top side of piston while on the bottom side of piston air again enters crankcase.

Upon piston reaching TDC fuel [Oil mixed] is injected into compressed air which is at high temperature and pressure. As fuel is injected into compressed air the fuel ignition gets set on its own due to temperature being more than self-ignition temperature of fuel, i.e. compression ignition.

Fuel injection is continued for some duration along with its ignition which causes release of excessive fuel energy. This energy release causes piston to go back from TDC to BDC, i.e. the expansion process as shown in (*c*).

As piston reaches BDC it simultaneously forces air in crank case to get transferred to cylinder space and forces burnt gases out of cylinder i.e. exhaust process. Here also cycle gets completed in single revolution of crankshaft i.e two processes occurring simultaneously in each stroke.

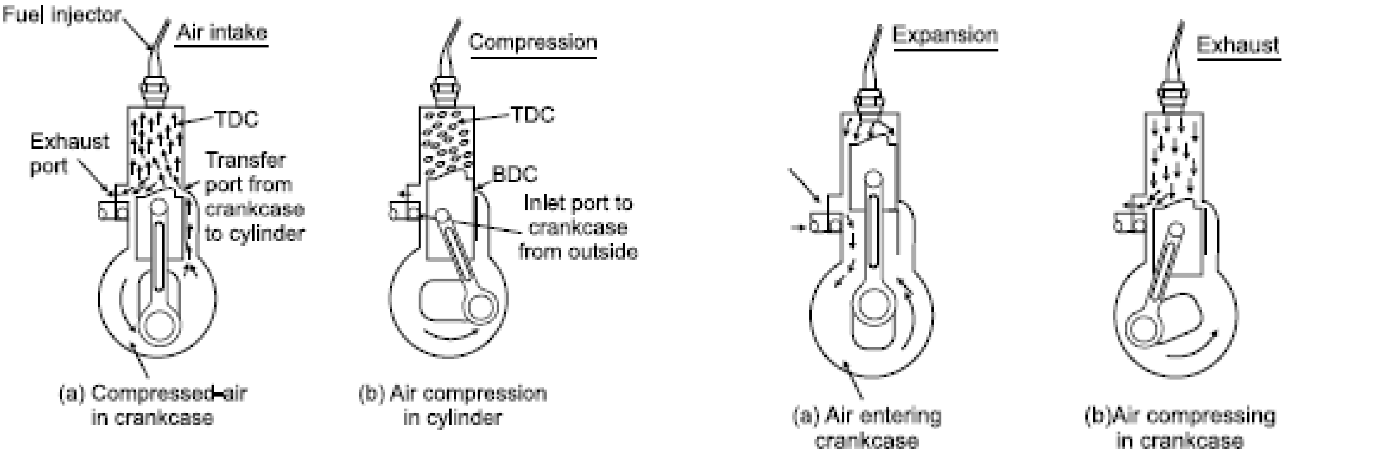

Figure 4.2: Working of two stroke CI Engine

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following questions

a) In Two stroke engine one cycle is completed in ______________revolution of crankshaft

b) What is the function of transfer case in two stroke engine?

c) ___________________Stroke is called power the stroke.

d) Write the difference between two stroke and four stroke CI engine

e) Which element is used instead of spark plug in CI engine?

EXPRIMENT NO. 5

Aim: Study and demonstration of domestic refrigerator

Objective: To study construction and working of refrigerator

Apparataus: A model of refrigerator

Introduction

Refrigeration technology is commonly used in domestic and industrial applications. This video gives a detailed and logical introduction to the workings of refrigerators using the vapor compression cycle.

The Basic Principle

The basic principle of refrigeration is simple. You simply pass a colder liquid continuously around the object that is to be cooled. This will take heat from the object. In the example shown, a cold liquid is passed over an apple, which is to be cooled. Due to the temperature difference, the apple loses heat to the refrigerant liquid. The refrigerant in turn is heated due to heat absorption from the apple.

If we can produce cold liquid refrigerant continuously, we can achieve continuous refrigeration. This simple fact forms the core of the refrigeration technology. We will next see how this is achieved.

Components of Refrigerator & Working

It has 4 main components: compressor, condenser, evaporator, and throttling device. Of these components, the throttling device is the one that is responsible for the production of the cold liquid. So we will first analyze the throttling device in a detailed way and move on to the other components.

Throttling Device

The throttling device obstructs the flow of liquid; cold liquid is produced with the help of this device. In this case, the throttling device is a capillary tube. The capillary tube has an approximate length of 2 m and an inside diameter of around 0.6 mm, so it offers considerable resistance to the flow.

For effective throttling at the inlet, the refrigerant should be a high-pressure liquid. The throttling device restricts the flow, which causes a tremendous pressure drop. Due to the drop in pressure, the boiling point of the refrigerant is lowered, and it starts to evaporate. The heat required for evaporation comes from the refrigerant itself, so it loses heat, and its temperature drops. If you check the temperature across the throttling device, you will notice this drop.

It is wrong to say that the throttling is a *process*. We know only the end points of throttling, that is, the states before and after throttling. We don't know the states in between, since this is a highly irreversible change. So it would be correct to call throttling a phenomenon rather than a process.

Evaporator - Heat Absorption Process

The cold liquid is passed over the body that has to be cooled. As a result, the refrigerant absorbs the heat. During the heat absorption process, the refrigerant further evaporates and transforms into pure vapor. A proper heat exchanger is required to carry the cold refrigerant over the body. This heat exchanger is known as an evaporator.

So we have produced the required refrigeration effect. If we can return this low-pressure vapor refrigerant to the state before the throttling process (that is the high-pressure liquid state), we will be able to repeat this process. So first step, let's raise the pressure.

Compressor

A compressor is introduced for this purpose. The compressor will raise the pressure back to its initial level. But since it is compressing gas, along with pressure, temperature will also be increased. This is unavoidable.

Now the refrigerant is a high-pressure vapor. To convert it to the liquid state, we must introduce another heat exchanger.

Condenser

This heat exchanger is fitted outside the refrigerator, and the refrigerant temperature is higher than atmospheric temperature. So heat will dissipate to the surroundings. The vapor will be condensed to liquid, and the temperature will return to a normal level.

So the refrigerant is back to its initial state again: a high-pressure liquid. We can repeat this cycle over and over for continuous refrigeration. This cycle is known as the ***vapor compression cycle***. Refrigeration technology based on the vapor compression cycle is the most commonly used one in domestic and industrial applications.

Refrigeration Accessories

Evaporators and condensers have fins attached to them. The fins increase the surface area available for convective heat transfer and thus will significantly enhance heat transfer. Since the evaporator is cooling the surrounding air, it is common that water will condense on it, forming frost. The frost will act as an insulator between the evaporator heat exchanger and the surrounding air. Thus it will reduce the effectiveness of the heat removal process. Frequent removal of frost is required to enhance the heat transfer. An automatic defrosting mechanism is employed in all modern refrigerators.

Compressor

Apart from raising the pressure, the compressor also helps maintain the flow in the refrigerant circuit. Usually, a hermetically sealed reciprocating type compressor is used for this purpose. You might have noticed that, your household refrigerator consumes a lot of electricity compared to the other devices. In a vapor compression cycle, we must compress the gas; compressing the gas and raising pressure is a highly energy intensive affair. This is the reason why the refrigerator based on the vapor compression refrigeration technology consumes a lot of electricity.

Coefficient of Performance

The heat and power transfer happening in a vapor compression refrigeration circuit is shown below. A simple energy balance of the system yields the following relationship.

$$P_{in} + Q_{ABSORBED} = Q_{REJECTED}$$

It is often required to evaluate performance of a refrigerator or compare between different refrigeration technologies. A term called Coefficient of Performance (C.O.P) helps in doing this. To understand this term completely, we need to know what is the input and output of a refrigeration system. What we need from a refrigerator is the cooling effect. Or $Q_{ABSORBED}$ is the output of a refrigeration cycle. Input to the refrigerator is the power given to the compressor. So the term C.O.P can easily be defined as output by input and is expressed as follows

COP =(Q_A/ RE)

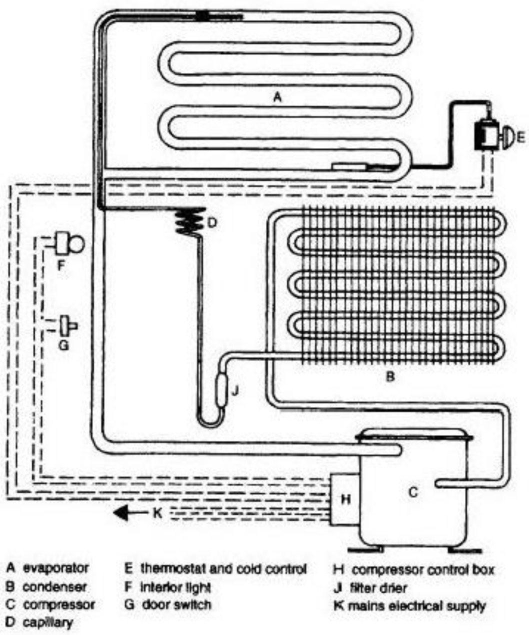

Figure 5.1. Basic Refrigeration Cycle

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following question

a) Enlist the main components of refrigerator

b) Refrigerator works on ___________________cycle

c) Explain the working principle of refrigerator

d) Phase change takes place in____________________________________and________________________________.

e) Pressure change takes place in________________________________and_________________________________

EXPERIMENT NO.6

Aim: Study and demonstration of window type air conditioner

Objective: To understand the construction and working principle of air conditioner

Apparataus: A model of air conditioner

Introduction:

is the process of altering the properties of air (primarily temperature and humidity) to more comfortable conditions, typically with the aim of distributing the conditioned air to an occupied space such as a building or a vehicle to improve thermal comfort and indoor air quality. In common use, an **air conditioner** is a device that lowers the air temperature.

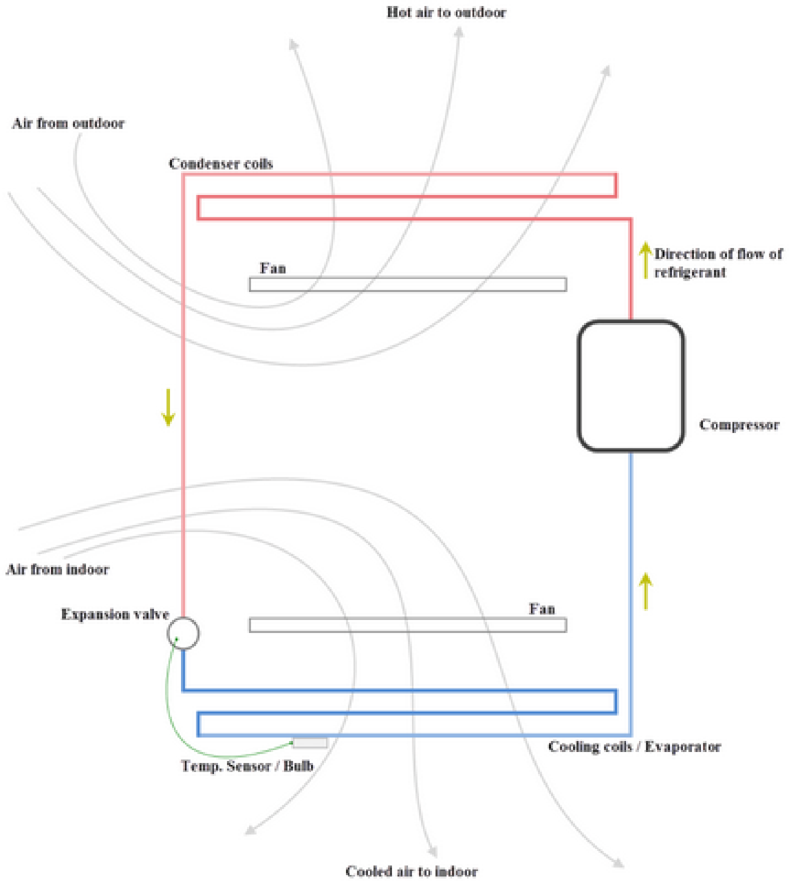

Figure 6.1: Basic mechanism and principle

Components of an air conditioner

The refrigerant is a substance that circulates through the air conditioner, alternately absorbing, transporting and releasing heat.

A coil is a system of tubing loops through which refrigerant flows and where heat transfer takes place. The tubing may have fins to increase the surface area available for heat exchange.

The evaporator is a coil that allows the refrigerant to absorb heat from its surroundings, causing the refrigerant to boil and become a low-temperature vapour.

The compressor squeezes the molecules of the refrigerant gas together, increasing the pressure and temperature of the refrigerant.

The condenser is a coil that allows the refrigerant gas to give off heat to its surroundings and become a liquid.

The expansion device releases the pressure created by the compressor. This causes the temperature to drop and the refrigerant to become a low-temperature vapour/liquid mixture.

The plenum is an air compartment that forms part of the system for distributing warmed or cooled air through the house. It is generally a large compartment immediately above the heat exchanger.

Other terms

A kW, or kilowatt, is equal to 1000 watts. This is the amount of power required by ten 100-watt light bulbs.

A ton is a measure of cooling capacity. It is equivalent to 3.5 kW or 12 000 Btu/h.

The capacity of an air conditioner is a measure of the maximum rate at which it can remove heat from the conditioned space. Capacity is expressed in British thermal units per hour or tons and is determined under a specific set of test conditions.

The cooling load, also stated in British thermal units per hour, is the maximum amount of heat that builds up in a space without a cooling system operating. It is calculated to determine the capacity of air conditioner required.

Heat gain is a term applied to various components of the heat load, such as appliance heat gain and solar heat gain. All the heat gain components are summed to calculate the cooling load.

Oversizing is the practice of selecting an air conditioner with a cooling capacity greater than the cooling load.

Under-sizing is the practice of selecting an air conditioner with a cooling capacity smaller than the cooling load.

The energy efficiency ratio (EER) is a measure of how much cooling effect is provided by the air conditioner for each unit of electrical energy that it consumes under steady-state operation. It is determined by dividing the cooling output of the unit, in British thermal units per hour, by the electrical power input, in watts, at a specific temperature.
The higher the EER, the more efficient the unit.

The seasonal energy efficiency ratio (SEER) is a measurement of the cooling efficiency of the air conditioner over the entire cooling season. It is determined by dividing the total cooling provided over the cooling season, in British thermal units per hour, by the total energy used by the air conditioner during that time, in watt/hours. The SEER is based on a climate with an average summer temperature of 28°C.

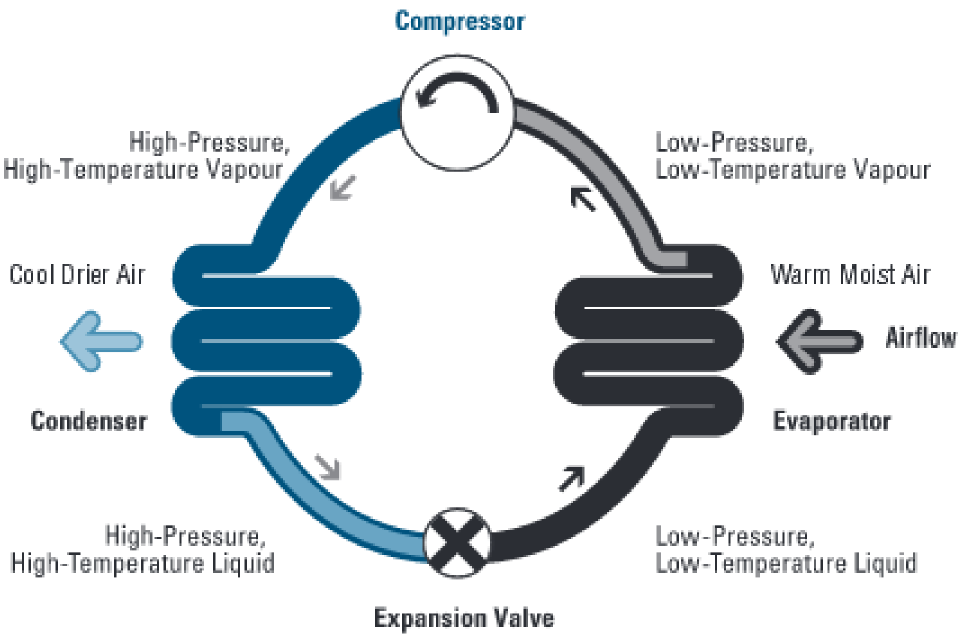

Figure 6.2: Refrigeration cycle

Working:

In the refrigeration cycle, heat is transported from a colder location to a hotter area. As heat, would naturally flow in the opposite direction, work is required to achieve this. A refrigerator is an example of such a system, as it transports the heat out of the interior and into its environment (i.e., the room). The refrigerant is used as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere.

Circulating refrigerant vapor enters the compressor and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed refrigerant vapor is now at a temperature and pressure at which it can be condensed and is routed through a condenser. Here it is cooled by air flowing across the condenser coils and condensed into a liquid. Thus, the circulating refrigerant removes heat from the system and the heat is carried away by the air.

The condensed and pressurized liquid refrigerant is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in flash evaporation of a part of the liquid refrigerant, lowering its temperature. The cold refrigerant is then routed through the evaporator. A fan blows the warm air (which is to be cooled) across the evaporator, causing the liquid part of the cold refrigerant mixture to evaporate as well, further lowering the temperature. The warm air is therefore cooled.

To complete the refrigeration cycle, the refrigerant vapor is routed back into the compressor.

By placing the condenser inside a compartment, and the evaporator in the ambient environment (such as outside), or by merely running an air conditioner's refrigerant in the opposite direction, the overall effect is the opposite, and the compartment is heated instead of cooled. See also heat pump.

The engineering of physical and thermodynamic properties of gas–vapor mixtures is called psychometrics.

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following question

a) Enlist the main components of Air conditioner
b) What is oversizing and undersizing?
c) What is meant by latent heat and sensible heat?
d) Which air properties are altered by air conditioner?
e) Define Energy Efficiency Ratio(EER)

EXPERIMENT NO.7

Aim: Study and demonstration of Lathe machine

Objective: To understand construction and different operations performed on lathe machine

Apparataus: Lathe machine

Introduction

The lathe is a machine tool which holds the workpiece between two rigid and strong supports called centers or in a chuck or face plate which revolves. The cutting tool is rigidly held and supported in a tool post which is fed against the revolving work. The normal cutting operations are performed with the cutting tool fed either parallel or at right angles to the axis of the work.

The cutting tool may also be fed at an angle relative to the axis of work for machining tapers and angles.

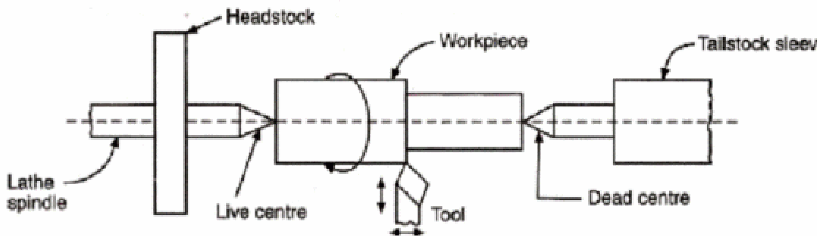

Figure 7.1: Working principle of lathe machine

Construction:

The main parts of the lathe are the bed, headstock, quick changing gear box, carriage and tailstock as shown in figure.

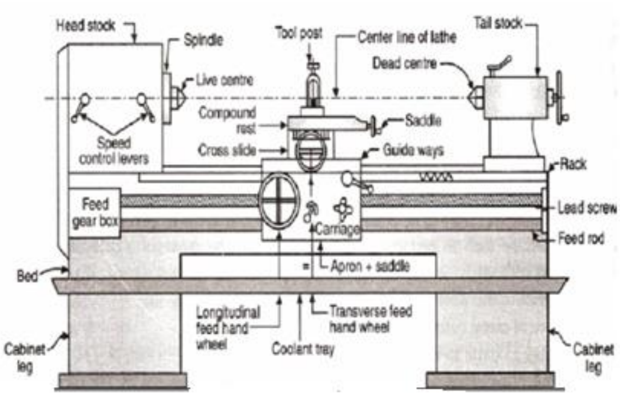

Figure7.2: Constructional details of Lathe machine

1. **Bed**: The bed is a heavy, rugged casting in which are mounted the working parts of the lathe. It carries the headstock and tail stock for supporting the workpiece and provides a base for the movement of carriage assembly which carries the tool.

2. **Legs:** The legs carry the entire load of machine and are firmly secured to floor by foundation bolts.

3. **Headstock**: The headstock is clamped on the left hand side of the bed and it serves as housing for the driving pulleys, back gears, headstock spindle, live centre and the feed reverse gear. The headstock spindle is a hollow cylindrical shaft that provides a drive from the motor to work holding devices.

4. **Gear Box**: The quick-change gear-box is placed below the headstock and contains a number of different sized gears.

5. **Carriage**: The carriage is located between the headstock and tailstock and serves the purpose of supporting, guiding and feeding the tool against the job during operation. The main parts of carriage are:

a). **The saddle** is an H-shaped casting mounted on the top of lathe ways. It provides support to cross-slide, compound rest and tool post.

b). **The cross slide** is mounted on the top of saddle, and it provides a mounted or automatic cross movement for the cutting tool.

c). **The compound rest** is fitted on the top of cross slide and is used to support the tool post and the cutting tool.

d). **The tool post** is mounted on the compound rest, and it rigidly clamps the cutting tool or tool holder at the proper height relative to the work centre line.

e). **The apron** is fastened to the saddle and it houses the gears, clutches and levers required to move the carriage or cross slide. The engagement of split nut lever and the automatic feed lever at the same time is prevented she carriage along the lathe bed.

6. **Tailstock**: The tailstock is a movable casting located opposite the headstock on the ways of the bed. The tailstock can slide along the bed to accommodate different lengths of workpiece between the centers. A tailstock clamp is provided to lock the tailstock at any desired position. The tailstock spindle has an internal taper to hold the dead center and the tapered shank tools such as reamers and drills.

Lathe operations

The engine lathe is an accurate and versatile machine on which many operations can be performed. These operations are:

Plain Turning: Plain turning is the operation of removing excess amount of material from the surface of a cylindrical job as shown in figure 7.3.

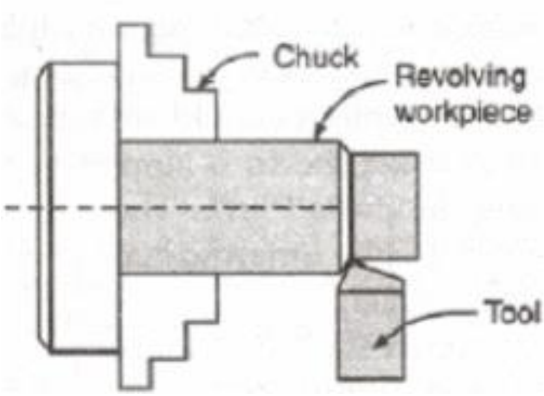

Figure 7.3: Plain Turning Operation

Step Turning: Step turning produces various steps of different diameters as shown in figure 7.4

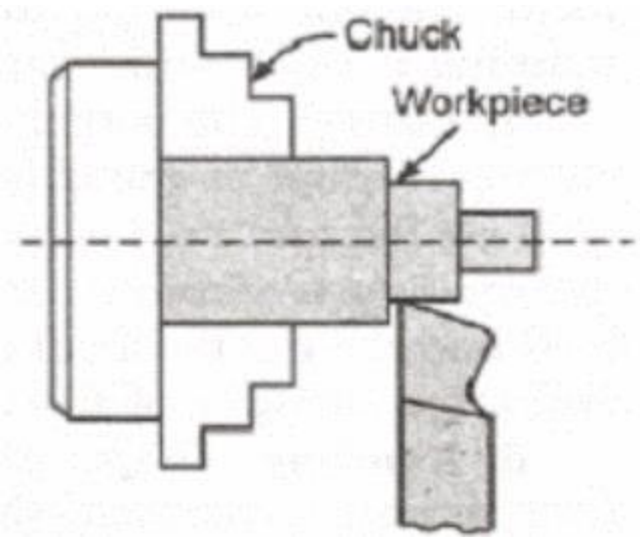

Figure 7.4: Step Turning Operation

Facing: The facing is a machining operation by which the end surface of the work piece is made flat by removing metal from it.

Parting: The parting or cutting off is the operation of cutting away a desired length of the workpiece, *i.e.*, dividing the workpiece in two or more parts as shown in figure 7.5.

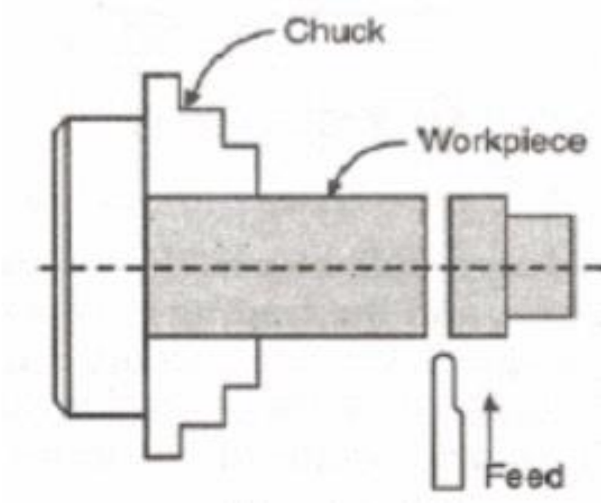

Figure 7.5: Parting Operation

Drilling: Drilling is the operation of producing a cylindrical hole in the workpiece as shown in figure 7.6.

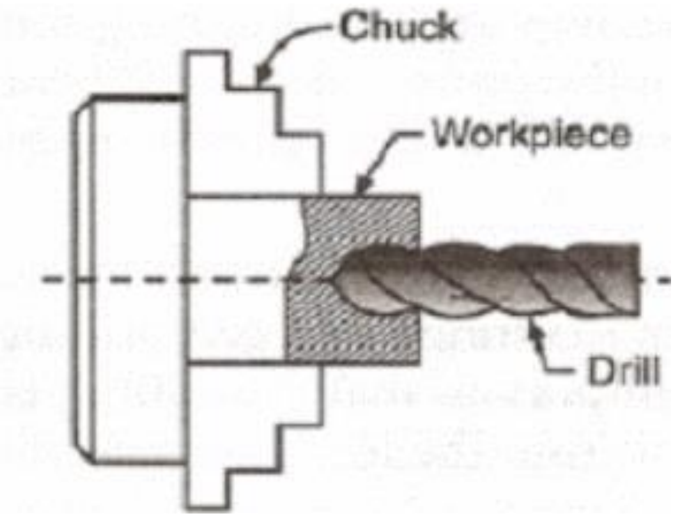

Figure 7.6: Drilling Operation

Reaming: The holes that are produced by drilling are rarely straight and cylindrical in form.

The reaming operation finishes and sizes the hole already drilled into the workpiece as shown in figure7.7.

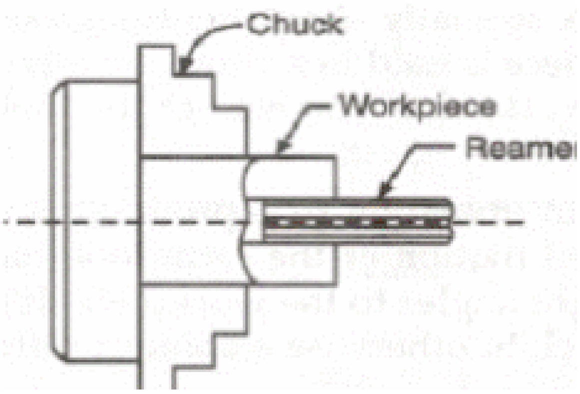

Figure 7.7: Reaming Operation

Boring: The boring operation is the process of enlarging a hole already produced by drilling as shown in figure 7.8.

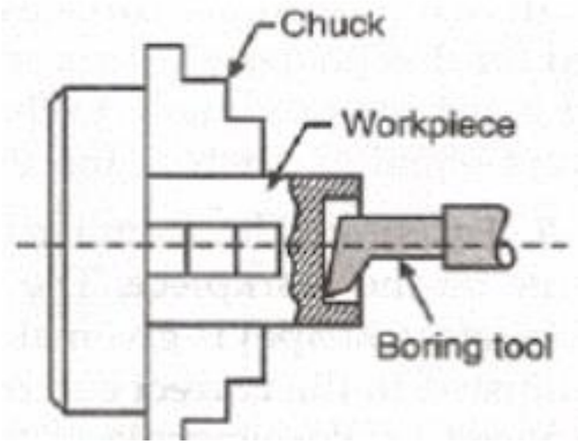

Figure 7.8: Boring Operation

Knurling: The knurling is a process of embossing (impressing) a diamond-shaped or straight-line pattern into the surface of workpiece as shown in figure 7.9. Knurling is essentially a roughening of the surface and is done to provide a better gripping surface.

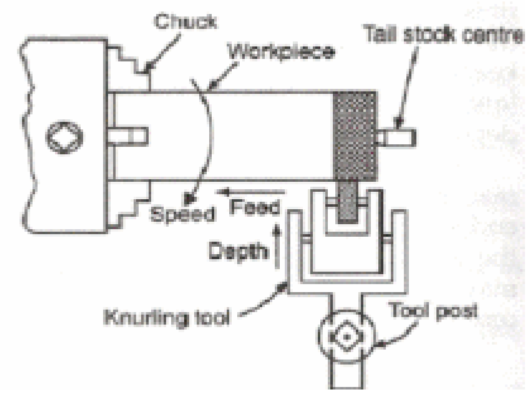

Figure 7.9: Knurling Operation

Grooving: Grooving is the act of making grooves of reduced diameter in the workpiece as shown in figure 7.10.

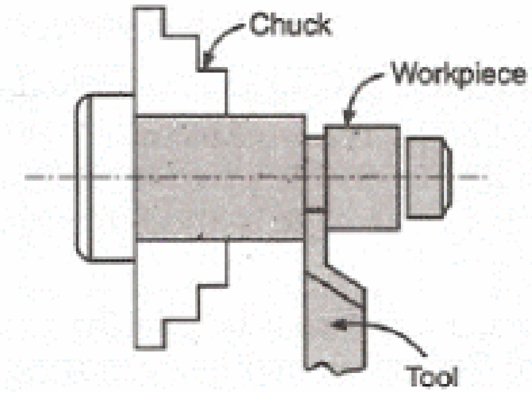

Figure 7.10: Grooving Operation

Threading: Threading is the act of cutting of the required form of threads on the internal or external cylindrical surfaces as shown in figure 7.11.

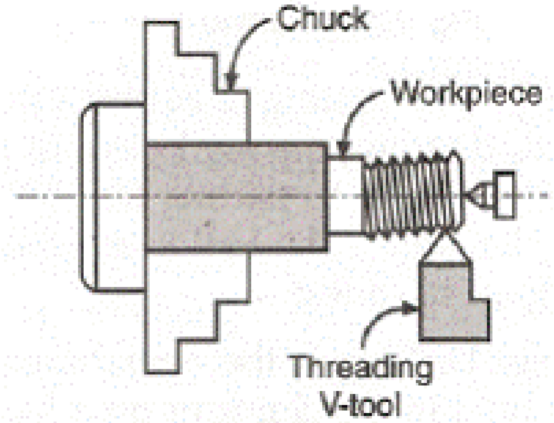

Figure 7.11: Threading Operation

Taper Turning: The taper turning is an operation of producing a conical surface by gradual reduction in the diameter of a cylindrical workpiece as shown in figure 7.12.

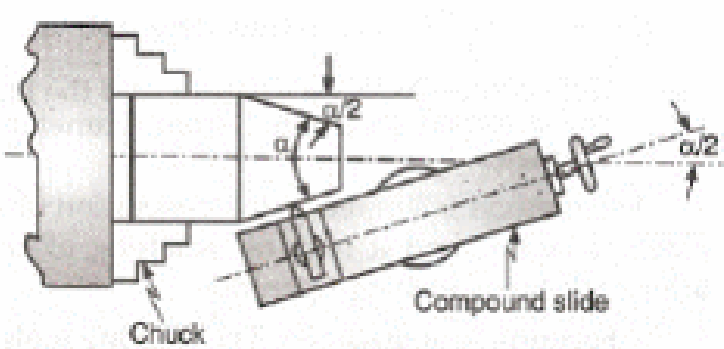

Figure 7.12: Taper TurningOperation

Chamfering: Chamfering removes the burrs and sharp edges, and thus makes the handling safe. Chamfering can be done by a form tool having angle equal to chamfer which is generally kept at 45°.

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer following questions: -

a)Enlist important parts of lathe machine.

2b) What is working principle of lathe machine?

c) In a lathe machine_______________________ cutting tool is used.

d) What is facing operation?

e) What are lathe attachments?

EXPERIMENT NO.8

Aim: Study and demonstration of Milling machine

Objective: To understand construction and different operations performed on milling machine

Apparataus: Milling Machine

Introduction:

Milling is the cutting operation that removes metal by feeding the work against a rotating, cutter having single or multiple cutting edges. Flat or curved surfaces of many shapes can be machined by milling with good finish and accuracy. A milling machine may also be used for drilling, slotting, making a circular profile and gear cutting by having suitable attachments.

Working Principle:

The workpiece is holding on the worktable of the machine. The table movement controls the feed of workpiece against the rotating cutter. The cutter is mounted on a spindle or arbor and revolves at high speed. Except for rotation the cutter has no other motion. As the workpiece advances, the cutter teeth remove the metal from the surface of workpiece and the desired shape is produced as shown in figure 8.1.

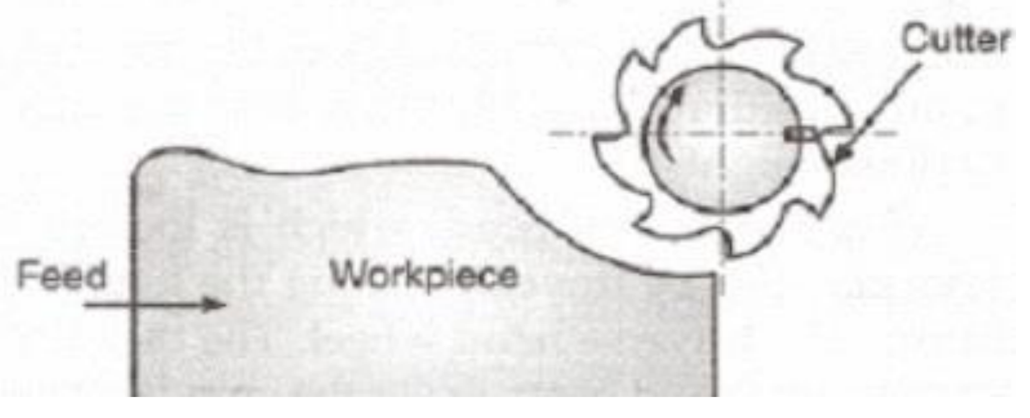

Figure 8.1: Working principle of milling machine

Horizontal Milling Machine Construction: The main parts of machine are base, Column, Knee, Saddle, Table, Overarm, Arbor Support and Elevating Screw as shown in figure 8.2.

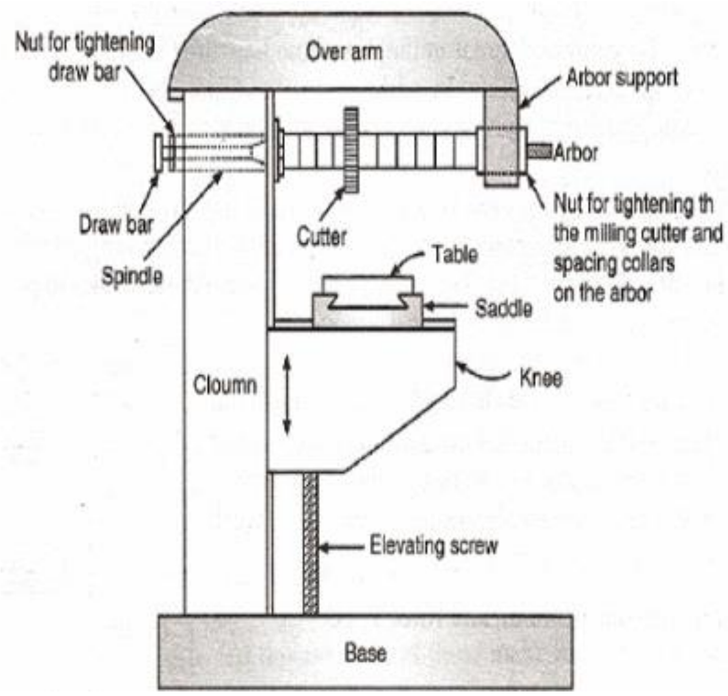

Figure 8.2: Constructional details of milling machine

1. **Base**: It gives support and rigidity to the machine and acts as a reservoir for the cutting fluids.

2. **Column**: The column is the main supporting frame mounted vertically on the base. The column is box shaped, heavily ribbed inside and houses all the driving mechanisms for the spindle and table feed.

3. **Knee**: The knee is a rigid casting mounted on the front face of the column. The knee moves vertically along the guide ways and this movement enables to adjust the distance between the cutter and the job mounted on the table. The adjustment is obtained manually or automatically by operating the elevating screw provided below the knee.

4. **Saddle**: The saddle rests on the knee and constitutes the intermediate part between the knee and the table. The saddle moves transversely, i.e., crosswise (in or out) on guide ways

provided on the knee.

5. **Table**: The table rests on guide ways in the saddle and provides support to the work. The table is made of cast iron, its top surface is accurately machined and carriers T-slots which accommodate the clamping bolt for fixing the work. The worktable and hence the job fitted on it is given motions in three directions:

a). Vertical (up and down) movement provided by raising or lowering the knee.

b). Cross (in or out) or transverse motion provided by moving the saddle in relation to knee.

c). Longitudinal (back and forth) motion provided by hand wheel fitted on the side of feed screw.

In addition to the above motions, the table of a universal milling machine can be swiveled 45° to either side of the centre line and thus fed at an angle to the spindle.

6. **Overar**m: The Overarm is mounted at the top of the column and is guided in perfect alignment by the machined surfaces. The Overarm is the support for the arbor.

7. **Arbor support**: The arbor support is fitted to the Overarm and can be clamped at any location on the Overarm. Its function is to align and support various arbors. The arbor is a machined shaft that holds and drives the cutters.

8. **Elevating screw**: The upward and downward movement to the knee and the table is given by the elevating screw that is operated by hand or an automatic feed.

Milling operation

Plain or slab milling: Machining of a flat surface which is parallel to the axis of the rotating cutter as shown in figure 8.3.

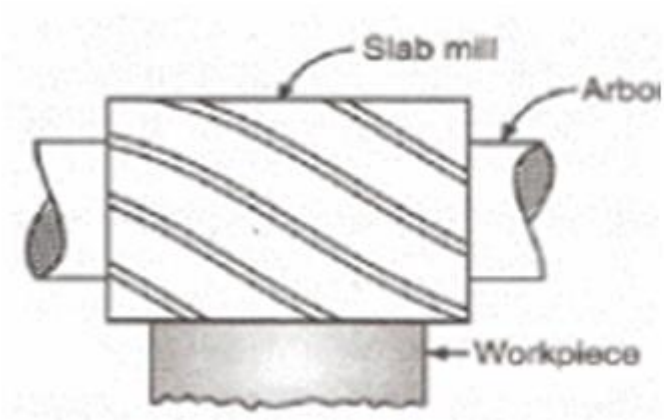

Figure 8.3: Slab Milling

Face milling: Machining of a flat surface which is at right angles to the axis of the rotating cutter as shown in figure 8.4.

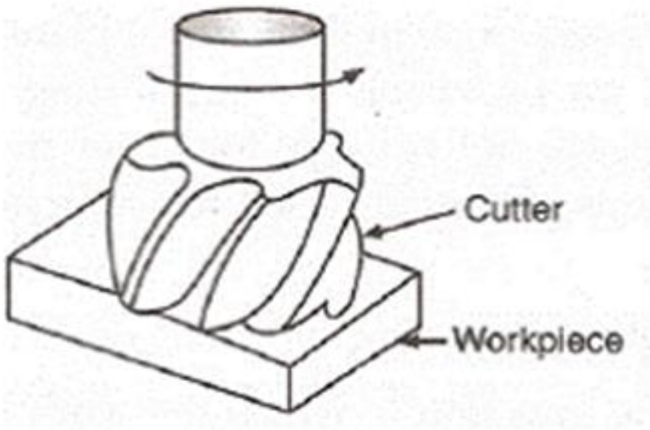

Figure 8.4: Face Milling

Angular milling: Machining of a flat surface at an angle, other than a right angle, to the axis of revolving cutter as shown in figure 8.5.

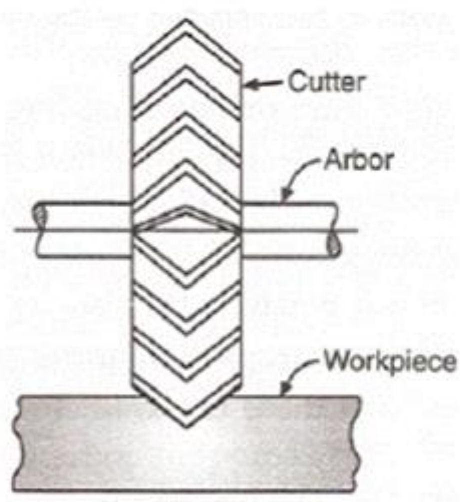

Figure 8.5: Angular Milling

Straddle milling: Simultaneous machining of two parallel vertical faces of the work-pieces by a pair of side milling cutters as shown in figure 8.6.

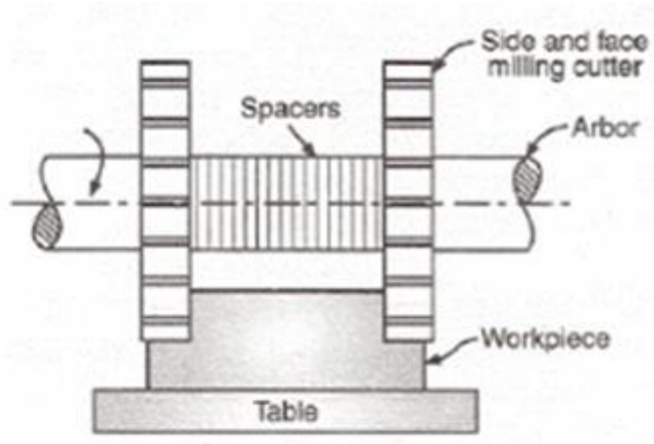

Figure 8.6: Straddle Milling

Form milling: Machining of surfaces which are of irregular shape. The teeth of the form milling cutter have a shape which corresponds to the profile of the surface to be produced as shown in figure 8.7.

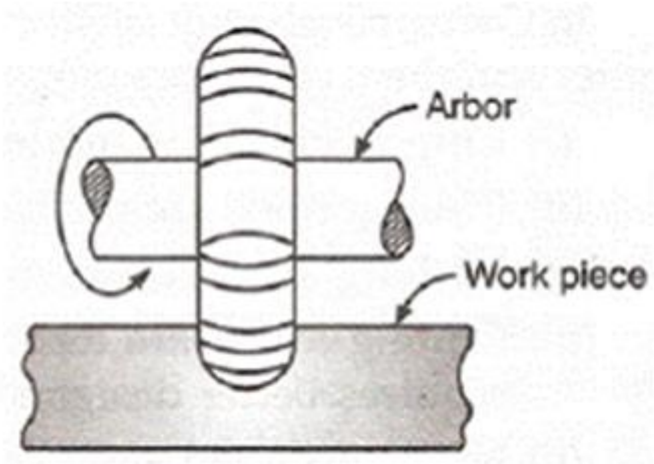

Figure 8.7: Form Milling

Gang milling: Simultaneous machining of a number of flat horizontal and vertical surfaces of a workpiece by using a combination of more than two cutters mounted on a common arbor as shown in figure 8.8.

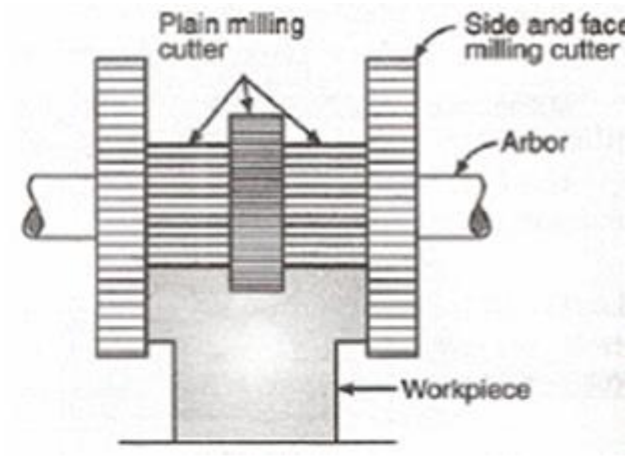

Figure 8.8: Gang Milling

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer following questions: -

1) Enlist important parts of milling machine.
2) What is Up milling and Down Milling?
3) In a Milling machine______________________ cutting tool is used.
4) Enlist different milling operations?
5) State milling machine operation?

EXPERIMENT NO.9

Aim: Study and demonstration of Shaper machine

Objective: To understand construction and different operations performed on shaper machine

Apparataus: Shaper Machine

Introduction: The shaper is a machine tool used primarily for:

1. Producing a flat or plane surface which may be in a horizontal, a vertical or an angular plane.
2. Making slots, grooves and keyways
3. Producing contour of concave/convex or a combination of these

Figure 9.1 shows the basic principle of generation of flat surface by shaping machine.

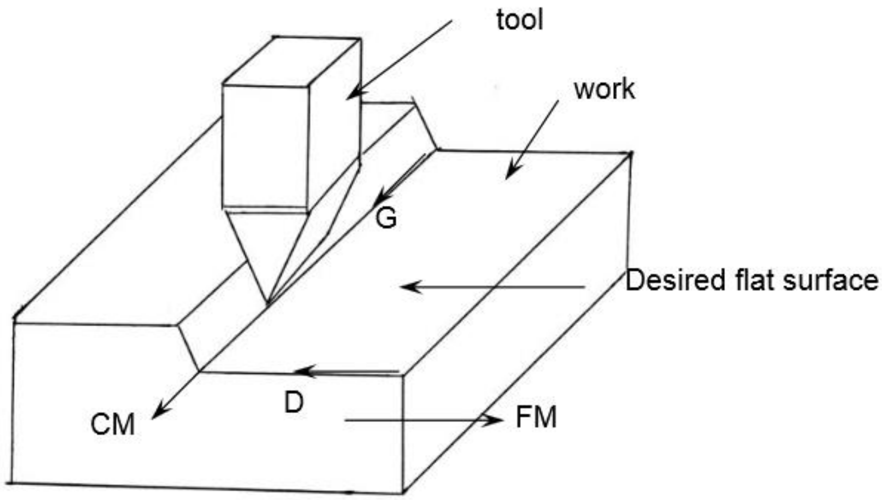

Figure 9.1: basic principle of generation of flat surface by shaping machine

Working Principle

The cutting motion provided by the linear forward motion of the reciprocating tool and the intermittent feed motion provided by the slow transverse motion of the job along with the bed result in producing a flat surface by gradual removal of excess material layer by layer in the form of chips. The vertical infeed is given either by descending the tool holder or raising the bed or both. Straight grooves of various curved sections are also made in shaping machines by using specific form tools. The single point straight or form tool is clamped in the vertical slide which is mounted at the front face of the reciprocating ram whereas the workpiece is directly or indirectly through a vice is mounted on the bed.

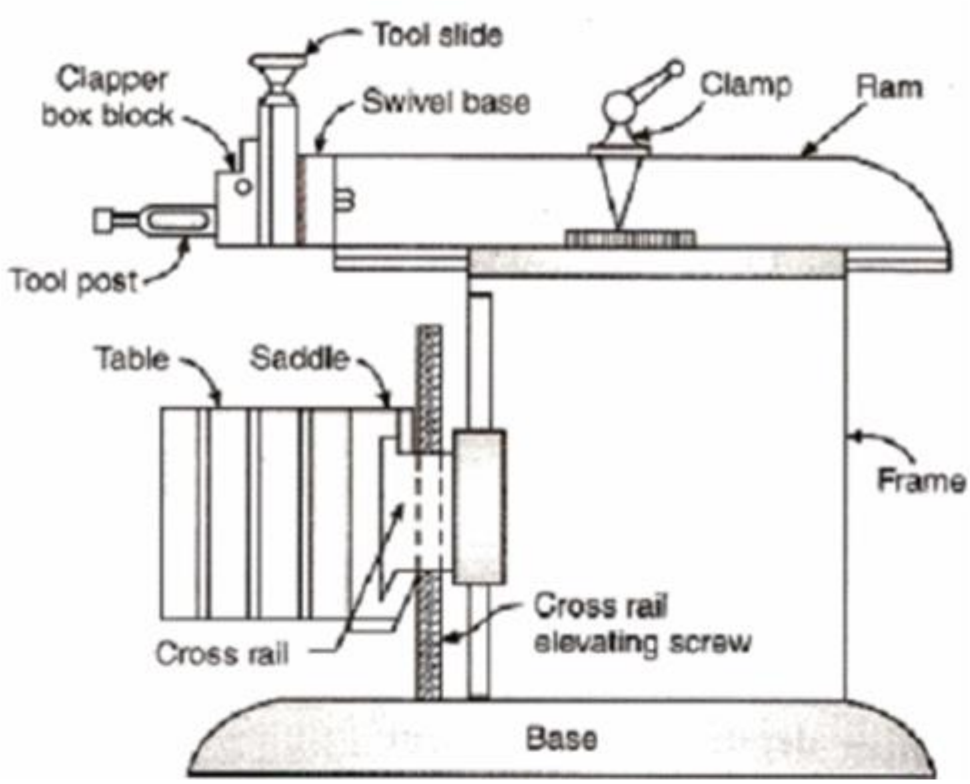

Figure 9.2: Constructional details of shaping machine.

Construction: The main parts of the Shaper machine is Base, Body (Pillar, Frame, Column), Cross rail, Ram and tool head (Tool Post, Tool Slide, Clamper Box Block) as shown in figure 9.2.

Base: The base is a heavy cast iron casting which is fixed to the shop floor. It supports the body frame and the entire load of the machine. The base absorbs and withstands vibrations and other forces which are likely to be induced during the shaping operations.

Body (Pillar, Frame, Column): It is mounted on the base and houses the drive mechanism compressing the main drives, the gear box and the quick return mechanism for the ram movement. The top of the body provides guide ways for the ram and its front provides the guide ways for the cross rail.

Cross rail: The cross rail is mounted on the front of the body frame and can be moved up and down. The vertical movement of the cross rail permits jobs of different heights to be accommodated below the tool. Sliding along the cross rail is a saddle which carries the work table.

Ram and tool head: The ram is driven back and forth in its slides by the slotted link mechanism. The back and forth movement of ram is called stroke and it can be adjusted according to the length of the workpiece to be-machined.

Conclusions: *[Student need to conclude the experiment in three to four lines]*

Answer the following question

a) Enlist the different parts of shaper machine
b) Forward stroke is Faster/Slower than the reverse stroke in shaping operation
c) Shaper machine works on __________mechanism.
d) What is the function of saddle in shaper machine?
e) Shaper machine uses________________ cutting tool.

EXPERIMENT NO.10

Aim: Study and demonstration of Radial drilling machine

Objective: To understand construction and different operations performed on drilling machine

Apparataus: Drilling machine

Introduction

Drilling is an operation of making a circular hole by removing a volume of metal from the job by cutting tool called drill. A drill is a rotary end-cutting tool with one or more cutting lips and usually one or more flutes for the passage of chips and the admission of cutting fluid. A drilling machine is a machine tool designed for drilling holes in metals. It is one of the most important and versatile machine tools in a workshop.

Construction of drilling machine

In drilling machine the drill is rotated and fed along its axis of rotation in the stationary workpiece. Different parts of a drilling machine are shown in Fig 10.1 and are discussed below:

- The head containing electric motor, V-pulleys and V-belt which transmit rotary motion to the drill spindle at several speeds.
- Spindle is made up of alloy steel. It rotates as well as moves up and down in a sleeve. A pinion engages a rack fixed onto the sleeve to provide vertical up and down motion of the spindle and hence the drill so that the same can be fed into the workpiece or withdrawn from it while drilling. Spindle speed or the drill speed is changed with the help of V-belt and V-step-pulleys. Larger drilling machines are having gear boxes for the said purpose.
- Drill chuck is held at the end of the drill spindle and in turn it holds the drill bit.
- Adjustable work piece table is supported on the column of the drilling machine. It can be moved both vertically and horizontally. Tables are generally having slots so that the vise or the workpiece can be securely held on it.
- Base table is a heavy casting and it supports the drill press structure. The base supports the column, which in turn, supports the table, head etc.
- Column is a vertical round or box section which rests on the base and supports the head

and the table. The round column may have rack teeth cut on it so that the table can be raised or lowered depending upon the workpiece requirements.

This machine consists of following parts

Parts name

1. Base
2. Column
3. Radial arm
4. Motor for elevating arm
5. Elevating screw
6. Guide ways
7. Motor for driving drill spindle
8. Drill head
9. Drill spindle
10. Table

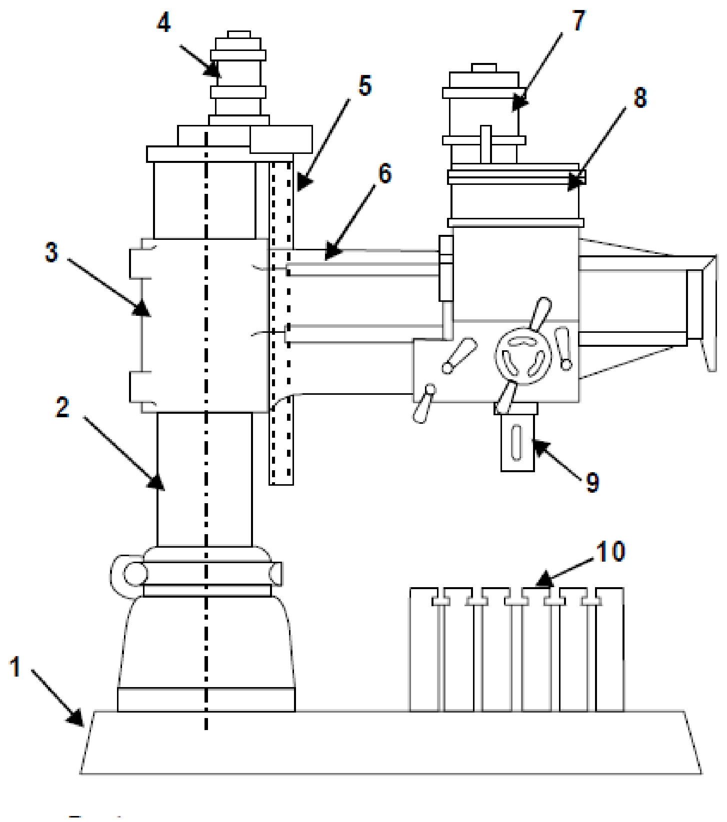

Figure 10.1: Constructional details of Drilling machine.

Working of Radial Drilling Machine

Fig. illustrates a radial drilling machine. The radial drilling machine consists of a heavy, round vertical column supporting a horizontal arm that carries the drill head. Arm can be raised or lowered on the column and can also be swung around to any position over the work and can be locked in any position. The drill head containing mechanism for rotating and feeding the drill is mounted on a radial arm and can be moved horizontally on the guide-ways and clamped at any desired position. These adjustments of arm and drilling head permit the operator to locate the drill quickly over any point on the work. The table of radial drilling machine may also be rotated through 360 deg. The maximum size of hole that the machine can drill is not more than 50 mm. Powerful drive motors are geared directly into the head of the machine and a wide range of power feeds are available as well as sensitive and geared manual feeds. The radial drilling machine is used primarily for drilling medium to large and heavy workpieces. Depending on the different movements of horizontal arm, table and drill head, the upright drilling machine may be classified into following types-

1. Plain radial drilling machine
2. Semi universal drilling machine, and
3. Universal drilling machine.

In a plain radial drilling machine, provisions are made for following three movements -

1. Vertical movement of the arm on the column,
2. Horizontal movement of the drill head along the arm, and
3. Circular movement of the arm in horizontal plane about the vertical column.

In a semi universal drilling machine, in addition to the above three movements, the drill head can be swung about a horizontal axis perpendicular to the arm. In universal machine, an additional rotatory movement of the arm holding the drill head on a horizontal axis is also provided for enabling it to drill on a job at any angle.

Conclusions: *[Student need to conclude the experiment in three to four lines]* ------------------------------

Answer the following question

a) Enlist the different parts of drilling machine.

b) Write the types of drilling machine

c) How drilling machine is specified?

d) Which types of operation can be performed on drilling machine?

e) In plain radial drilling machine which kind of movements can be achieved?