LABORATORY MANUAL

Thermodynamics

(ME 306)

Department of Mechanical Engineering

Jorhat Engineering College
Jorhat – 785007 (Assam)

COLLEGE VISION AND MISSION

Vision:

To develop human resources for sustainable industrial and societal growth through excellence in technical education and research.

Mission:

1. To impart quality technical education at UG, PG and PhD levels through good academic support facilities.

2. To provide an environment conducive to innovation and creativity, group work and entrepreneurial leadership.

3. To develop a system for effective interactions among industries, academia, alumni and other stakeholders.

4. To provide a platform for need-based research with special focus on regional development.

DEPARTMENT VISION AND MISSION

Vision:

To emerge as a centre of excellence in mechanical engineering and maintain it through continuous effective teaching-learning process and need-based research.

Mission:

M1: To adopt effective teaching-learning processes to build students capacity and enhance their skills.

M2: To nurture the students to adapt to the changing needs in academic and industrial aspirations.

M3: To develop professionals to meet industrial and societal challenges.

M4: To motivate students for entrepreneurial ventures for nation-building.

Program Outcomes (POs)

Engineering graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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.

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.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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.

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.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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.

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.

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.

Programme Educational Objectives (PEOs)

The Programme Educational Objectives of Department of Mechanical Engineering are given below:

PEO1: Gain basic domain knowledge, expertise and self-confidence for employment, advanced studies, R&D, entrepreneurial ventures activities, and facing challenges in professional life.

PEO2: Develop, improve and maintain effective domain based systems, tools and techniques that socioeconomically feasible and acceptable and transfer those technologies/developments for improving quality of life.

PEO3: Demonstrate professionalism through effective communication skill, ethical and societal commitment, team spirit, leadership quality and get involved in life-long learning to realize career and organisational goal and participate in nation building.

Program Specific Outcomes (PSOs)

The programme specific outcomes of Department of Mechanical Engineering are given below:

PSO1: Capable to establish a career in Mechanical and interdisciplinary areas with the commitment to the society and the nation.

PSO2: Graduates will be armed with engineering principles, analysing tools and techniques and creative ideas to analyse, interpret and improve mechanical engineering systems.

Course Outcomes (COs)

At the end of the course, the student will be able to:

CO1	Identify the different types of boilers, mounting and accessories.
CO2	Identify the different parts of 2-stroke and 4-stroke Petrol and Diesel engines.

Mapping of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1						1		1			1	2
CO2	2	1						1		1			1	2

STUDENT PROFILE	
NAME :	
ROLL NUMBER :	
SECTION :	
SEMESTER :	3rd Semester
YEAR :	

PERFORMANCE RECORD		
EXP. NO.	**TITLE OF EXPERIMENT**	**REMARKS / GRADE**
1	**Study of different types of boilers.**	
1(A)	**Study of a Babcock and Wilcox boiler.** (a) To make a neat pencil sketch of the boiler and label all the parts. (b) To make a list of the mountings and accessories provided in the boiler. (c) To describe the working principle of the boiler.	
1(B)	**Study of a Locomotive boiler.** (a) To make a neat pencil sketch of the boiler and label all the parts. (b) To make a list of the mountings and accessories provided in the boiler. (c) To describe the working principle of the boiler.	
1(C)	**Study of a Cochran boiler.** (a) To make a neat pencil sketch of the boiler and label all the parts. (b) To make a list of the mountings and accessories provided in the boiler. (c) To describe the working principle of the boiler.	
1(D)	**Study of a Lancashire boiler.** (a) To make a neat pencil sketch of the boiler and label all the	

	parts. (b) To make a list of the mountings and accessories provided in the boiler. (c) To describe the working principle of the boiler.	
2	**Study of Boiler (A) Mountings, and (B) Accessories.**	
2(A)	Study of Boiler Mountings.	
2(B)	Study of Boiler Accessories.	
3	**Study of 2-Stroke and 4-Stroke Petrol Engine.** (a) To make neat pencil sketches showing the different strokes in each case and level all the parts. (b) To prepare a list of all the important parts. (c) To describe the working principles of each cycle.	
4	**Study of 2-Stroke and 4-Stroke Diesel Engine.** (a) To make neat pencil sketches showing the different strokes in each case and level all the parts. (b) To prepare a list of all the important parts. (c) To describe the working principles of each cycle.	

OFFICE USE	
Checked By :	
Overall Grade / Marks :	
Signature of Teacher :	

Experiment No. 1

TITLE: Study of different types of boilers.

THEORY:

A boiler is used to generate steam at a desired pressure and temperature by transferring heat produced by burning fuel to water to change it to steam. It is a term applied to that device which generates steam at minimum pressure of 3.5 bar having minimum capacity of 22.75 litres.

According to A.S.M.E, "combustion of apparatus for producing or recovering heat together with the apparatus for transferring the heat so made available to the fluid being heated and vaporized.

The primary requirements of steam generator or boiler are:

1. Water
2. Water drum
3. Fuel for heating

Classification of Boilers:

The boilers may be classified according to following criteria:

1. **According to relative position of water and hot gases:**
   (a) Water tube boiler: A boiler in which the water flows through the tubes which are surrounded by hot combustion gases i.e. Babcock and Wilcox, Stirling, Benson boilers etc.
   (b) Fire tube boiler: The hot combustion gases pass through the boiler tubes, which are surrounded by water i.e. Lancashire, Cochran, Locomotive boilers etc.
2. **According to water circulation arrangement:**
   (a) Natural circulation: Water circulates in the boiler due to density difference of hot and cold water e.g., Babcock and Wilcox boiler, Lancashire boiler, Locomotive boiler etc.
   (b) Forced circulation: A water pump forces the water along its path, therefore, the steam generation rate increases e.g.. Benson, La Mont, Velox boilers etc.
3. **According to position of furnaces:**
   (a) Internally fired: The furnace is located inside the shell e.g., Cochran, Lancashire boilers etc.

(b) Externally fired: The furnace is located outside the boiler shell i.e. Babcock and Wilcox, Stirling boilers etc.

4. According to the use: Stationary, Portable, Locomotive or marine boiler.
5. According to position of the boilers: horizontal, inclined or vertical boilers.

Experiment No. 1 (A)

AIM: **To Study the Babcock & Wilcox Boilers**.

APPARATUS USED: Model of Babcock & Wilcox Boilers.

THEORY:

Babcock and Wilcox is a horizontal inclined water-tube high pressure boiler.

CONSTRUCTION:

Babcock and Wilcox boiler with longitudinal drum. It consists of a drum connected to a series of front end and rear end header by short riser tubes. To these headers are connected a series of inclined water tubes of solid drawn mild steel. The angle of inclination of the water tubes to the horizontal is about 15° or more.

WORKING:

Coal is fed to the grate through the fire door and is burnt.

Flow of flue gases:

The hot flue gases rise upward and pass across the left-side portion of the water tubes. The baffles deflect the flue gases and hence the flue gases travel in the zig-zag manner (i.e., the hot gases are deflected by the baffles to move in the upward direction, then downward and again in the upward direction) over the water tubes and along the superheater. The flue gases finally escape to atmosphere through chimney.

Water circulation:

That portion of water tubes which is just above the furnace is heated comparatively at a higher temperature than the rest of it. Water, its density being decreased, rises into the drum through the uptake-header. Here the steam and water are separated in the drum. Steam being lighter is collected in the upper part of the drum. The water from the drum comes down through the down –comer into the water tubes.

A continuous circulation of water from the drum to the water tubes and water tubes to the drum is thus maintained. The circulation of water is maintained by convective currents and is known as **"natural circulation**".

A damper is fitted as shown to regulate the flue gas outlet and hence the draught. The boiler is fitted with necessary mountings. Pressure gauge and water level indicator are mounted on the boiler at its left end. Steam safety valve and stop valve are mounted on the top of the drum. Blow-off cock is provided for the periodical removed of mud and sediments collected in the mud box.

Salient features of Babcock and Wilcox Boiler:

1. Its overall efficiency is higher than a fire tube boiler.
2. The defective tubes can be replaced easily.
3. All the components are accessible for inspection even during the operation.
4. The draught loss is minimum compared with other boiler.
5. Steam generation capacity and operating pressure are high compared with other boilers.
6. The boiler rests over a steel structure independent of brick work so that the boiler may expand or contract freely.
7. The water tubes are kept inclined at an angle of 10 to 15 degree to promote water circulation.

Assignment: Draw a schematic diagram of Babcock & Wilcox Boilers and label different components Babcock.

Exp. No. 1(A)	**Title:** To Study the Babcock & Wilcox Boilers.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

Experiment No. 1(B)

AIM: To Study the Locomotive Boiler.

APPARATUS USED: Model of Locomotive Boiler.

THEORY:

A fire-tube boiler is a type of boiler in which hot gases from a fire pass through one or more tubes running through a sealed container of water. The heat energy from the gases passes through the sides of the tubes by thermal conduction, heating the water and ultimately creating steam.

The fire-tube boiler developed as the second of the three major historical types of boilers: low-pressure tank or "haystack" this type of boiler was used on virtually all steam locomotives in the horizontal "locomotive" form. This has a cylindrical barrel containing the fire tubes, but also has an extension at one end to house the “firebox”. This firebox has an open base to provide a large grate area and often extends beyond the cylindrical barrel to form a rectangular or tapered enclosure. A fire-tube boiler is sometimes called a “smoke-tube boiler” or "shell boiler" or sometimes just “fire pipe”.

A locomotive boiler is a fire tube, internally fixed, horizontally, multi tubular boiler. It is mainly employed in locomotives through it may also be used as a stationary boiler. The hot gasses which are generated due to burning of the coal are deflected by an arch of a fire bricks, so that walls of the fire box may be heated properly. In the locomotive-type boiler, fuel is burnt in a firebox to produce hot combustion gases. The firebox is surrounded by a cooling jacket of water connected to the long, cylindrical boiler shell. The hot gases are directed along a series of fire tubes, or flues, that penetrate the boiler and heat the water thereby generating saturated (“wet”) steam.

In the locomotive boiler, the saturated steam is very often passed into a superheater, back through the larger flues at the top of the boiler, to dry the steam and heat it to superheated steam. Draught for fire tube boilers, particularly in marine applications, is usually provided by a tall partial vacuum. Modern industrial boilers use fans to provide forced or induced draughting of the boiler.

Locomotive-type boilers are also used in traction engines, steam rollers, portable engines and some other steam road vehicles. The inherent strength of the boiler means it is used as the basis for the vehicle: all the other components, including the wheels, are mounted on brackets attached to the boiler. It is rare to find superheaters designed into this type of boiler, and they are generally much smaller (and simpler) than railway locomotive types.

Assignment: Draw a schematic diagram of Locomotive Boiler and label different components.

Exp. No. 1(B)	**Title:** To Study the Locomotive Boiler.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

Experiment No. 1(C)

AIM: To Study the Cochran Boiler.

APPARATUS USED: Model of Cochran Boiler

THEORY:

It is a multi-tubular vertical fire tube boiler having a number of horizontal fire tubes. It is a low pressure boiler and is used in small plants requiring small quantities of steam and where the floor area is limited.

CONSTRUCTION:

Cochran boiler consists of a cylindrical shell with a dome shaped top where the space is provided for steam. The furnace is one piece construction and is seamless. Its crown has a hemispherical shape and thus provides maximum volume of space. It consists of:

(a) Shell: It is hemispherical on the top, where space is provided for steam.

(b) Grate: It is placed at the bottom of the furnace where coal is burnt.

(c) Fire box (furnace): It is also dome-shaped like the shell so that the gases can be deflected back till they are passed out through the flue pipe to the combustion chamber.

(d) Flue pipe: It is a short passage connecting the fire box with the combustion chamber.

(e) Fire tubes: A number of horizontal fire tubes are provided, thereby the heating surface is increased.

(f) Combustion chamber: It is lined with fire bricks on the side of the shell to prevent overheating of the boiler. Hot gases enter the fire tubes from the flue pipe through the combustion chamber.

(g) Chimney: It is provided for the exit of the flue gases to the atmosphere from the smoke box.

(h) Manhole: It is provided for inspection and repair of the interior of the boiler shell.

WORKING:

The coal is fed through the fire door to the grate with fire bars on it. The boiler can also work as an oil fired unit by fitting an oil burner at fire door. The grate is then dispensed with and a lining of fire bricks are provided beneath the furnace. 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 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 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 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 dia. 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 the form of plates. Finally the flue gases are discharged to the atmosphere through the smoke box and the chimney.

Salient features of Cochran boiler:

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

Assignment: Draw a schematic diagram of Cochran Boilers and label different components.

Exp. No. 1(C)	**Title:** To Study the Cochran Boiler.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

Experiment No. 1(D)

AIM: To Study the Lancashire Boiler.

APPARATUS USED: Model of Lancashire Boiler

CONSTRUCTION: It consists of:

1. Cylindrical shell
2. Furnace tubes, bottom flue and side flues
3. Grate
4. Fire bridge
5. Dampers

1. **Cylindrical shell:** It is placed in horizontal position over a brick work. It is partly filled up with water. The water level inside the shell is well above the furnace tubes.
2. **Furnace tubes, bottom flue and side flues:** Two large internal furnace tubes (flue tubes) extend from one end to the other end of the shell. The flues are built-up of ordinary brick lined with fire bricks. One bottom flue and two side flues are formed by brick setting, as shown in the figure.
3. **Grate:** The grate is provided at the front end of the main flue tubes. Coal is fed to the grate through the fire hole.
4. **Fire Bridge:** A brickwork fire bridge is provided at the end of the grate to prevent the flow of coal and ash particles into the interior of the furnace (flue) tubes. Otherwise the coal and ash particles carried with gases form deposits on the interior of the tubes and prevent the heat transfer to the water.
5. **Dampers:** Dampers is in the form of sliding doors are placed at the end of the side flues to control the flow of gases from side flues to the chimney flue.

WORKING OF LANCASHIRE BOILER:

Coal is fed to the grate through the fire hole and is burnt. The hot gases leaving the grate move along the furnace (flue) tubes up to the back end of the shell and then in the downward direction to the bottom flue. The bottom of the shell is thus first heated.

The hot gases, passing through the bottom flue, travel upto the front end of the boiler, where they divide into two streams and pass to the side flues. This makes the two sides of the boiler shell to become heated. Passing along the two side flues, the hot gases travel upto the

back end of the boiler to the chimney flue. They are then discharged into the atmosphere through the chimney.

With the help of this arrangement of flow passages of hot gases, the bottom of the shell is first heated and then its sides. The heat is transferred to water through the surface of the two flue tubes (which remain in water) and bottom and sides of the shell.

The arrangement of flues increases the heating surface of the boiler to a large extent. Dampers control the flow of hot gases and regulate the combustion rate as well as steam generation rate. The boiler is fitted with necessary mountings. Pressure gauge and water level indicator provided at the front. Safety valve, steam stop valve, low water and high steam safety valve and man-hole are provided on the top of the shell.

Salient features of Lancashire Boiler:

1. The arrangement of flues in this boiler increases the heating surface of shell to a large extent.
2. It is suitable where a large reserve of steam and hot water is needed.
3. Its maintenance is easy.
4. Superheated can be easily incorporated into the system at the end of the main flue tubes. Thus overall efficiency of the boiler can be increased.

Assignment: Draw a schematic diagram of Lancashire Boilers and label different components

Exp. No. 1(D)	**Title:** To Study the Lancashire Boiler.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

Experiment No. 2

AIM: Study of Boiler (A) Mountings, and (B) Accessories.

THEORY: Boilers are equipped with two categories of components:

(A) Boiler Mountings.

(B) Boiler Accessories.

(A) BOILER MOUNTINGS:

The boiler mountings are the part of the boiler and are required for proper functioning. In accordance with the Indian Boiler regulations, of the boiler mountings is essential fitting for safe working of a boiler. Some of the important mountings are:

Various boiler mountings are as under:

1. Safety valve
2. Water level indicator
3. Pressure gauge
4. Fusible plug
5. Feed check valve
6. Blow-off cock
7. Steam stop valve

1. Safety Valve:

Safety valves are located on the top of the boiler. They guard the boiler against the excessive high pressure of steam inside the drum. If the pressure of steam in the boiler drum exceeds the working pressure then the safety valve allows blow-off the excess quantity of steam to atmosphere. Thus the pressure of steam in the drum falls. The escape of steam makes an audio noise to warm the boiler attendant.

There are four types of safety valve.

(a) Dead weight safety valve.
(b) Spring loaded safety valve.
(c) Lever loaded safety valve.
(d) High steam and low water safety valve.

2. Water level Indicator:

Water level indicator is located in front of boiler in such a position that the level of water can easily be seen by attendant. Usually two water level indicators are fitted in front of the boiler.

The water indicator shows the level or water in the boiler drum and warns the operator if by chance the water level goes below a fixed mark, so that corrective action may be taken in time, to avoid any accident.

3. Pressure Gauge:

A pressure gauge is fitted in front of boiler in such a position that the operator can conveniently read it. It reads the pressure of steam in the boiler and is connected to steam space by a siphon tube. The most commonly, the Bourdon pressure gauge is used.

4. Fusible Plug:

It is very important safety device, which protects the fire tube boiler against overheating. It is located just above the furnace in the boiler. It consists of gun metal plug fixed in a gun metal body with fusible molten metal. During the normal boiler operation, the fusible plug is covered by water and its temperature does not rise to its melting state. But when the water level falls too low in the boiler, it uncovers the fusible plug. The furnace gases heat up the plug and fusible metal of plug melts, the inner plug falls down The water and steam then rush through the hole and extinguish the fire before any major damage occurs to the boiler due to overheating.

5. Feed Check Valve:

The feed check valve is fitted to the boiler, slightly below the working level in the boiler. It is used to supply high pressure feed water to boiler. It also prevents the returning of feed water from the boiler if feed pump fails to work.

6. Blow-Off Cock:

The function of blow-off cock is to discharge mud and other sediments deposited in the bottom most part of the water space in the boiler, while boiler is in operation. It can also be used to drain-off boiler water. Hence it is mounted at the lowest part of the boiler. When it is open, water under the pressure rushes out, thus carrying sediments and mud.

7. Steam Stop Valve:

The steam stop valve is located on the highest part of the steam space. It regulates the steam supply to use. The steam stop valve can be operated manually or automatically.

Assignment 2(A): Draw the following Boiler Mountings.

(1) Safety valve, (2) Water level indicator, (3) Pressure gauge, (4) Fusible plug, (5) Feed check valve, (6) Blow-off cock, (7) Steam stop valve.

Exp. No. 2(A)	**Title:** Study of Boiler Mountings.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

(B) BOILER ACCESSORIES:

The accessories are mounted on the boiler to increase its efficiency. These units are optional on an efficient boiler. With addition of accessories on the boiler, the plant efficiency also increases. The following accessories are normally used on a modern boiler:

1. Economizer
2. Super heater
3. Air pre heater
4. Feed water pump
5. Steam injector.

1. Economizer:

An economizer is a heat exchanger, used for heating the feed water before it enters the boiler. The economizer recovers some of waste heat of hot flue gases going to chimney. It helps in improving the boiler efficiency. It is placed in the path of flue gases at the rear end of the boiler just before air pre-heater.

2. Super heater:

It is a heat exchanger in which heat of combustion products is used to dry the wet steam, pressure remains constant, its volume and temperature increase. Basically, a super heater consists of a set of small diameter U tubes in which steam flows and takes up the heat from hot flue gases.

3. Air Pre-heater:

The function of an air pre-heater is similar to that of an economizer. It recovers some portion of the waste heat of hot flue gases going to chimney, and transfers same to the fresh air before it enters the combustion chamber. Due to preheating of air, the furnace temperature increases. It results in rapid combustion of fuel with less soot, smoke and ash. The high furnace temperature can permit low grade fuel with less atmospheric pollution. The air pre-heater is placed between economizer and chimney.

4. Feed Water Pump:

It is used to feed the water at a high pressure against the high pressure of steam already existing inside the boiler.

5. Steam Injector:

A steam injector lifts and forces the feed water into the boiler. It is usually used for vertical and locomotive boilers and can be accommodated in small space. It is less costly. It does not have any moving parts thus operation is salient.

Assignment 2(B): Draw the following Boiler Accessories.

(1) Economizer, (2) Super heater, (3) Air pre heater, (4) Feed water pump, (5) Steam injector.

Exp. No. 2(B)	**Title:** Study of Boiler Accessories.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

Experiment No. 3

AIM: Study of Two Stroke & Four Stroke Petrol Engine.

THEORY:

(A) WORKING OFN FOUR STROKE PETROL ENGINE:

In a four stroke engine, the cycles of operations is completed in 4 strokes of piston or 2 revolution of crank shaft. Each stroke consists of 180° & hence the fuel cycle consists of 720° of crank rotation. The 4-Strokes are:

1. **SUCTION STROKE:**

   During this stroke the piston moves from TDC to BDC, the inlet valve open and proportionate fuel-air mixture is sucked in the engine cylinder.

2. **COMPRESSION STROKE:**

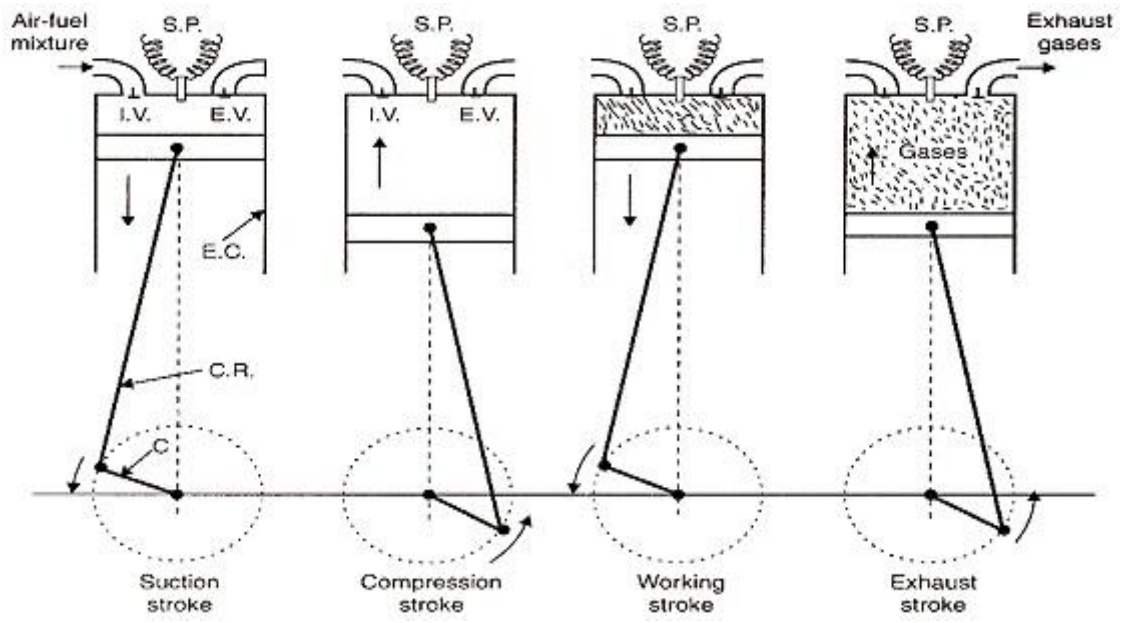
   In this stroke, the piston moves towards TDC and compressors the enclosed fuel air mixture drawn in the engine cylinder during suction. Both the inlet and exhaust valves remain closed during the stroke.

3. **EXPANSION STROKE:**

   When the mixture is ignited by the spark plug the hot gases are produced which drive or through the piston from T.D.C to B.D.C and thus the work is obtained in this stroke. A spark plug which ignites the mixture & combustion takes place at constant volume. Both the valves remain closed during the start of this stroke but when the piston just reaches the B.D.C the exhaust valve opens.

4. **EXHAUST STROKE:**

   This is the last stroke of the cycle. Here the gases from which the work has been collected become useless after the completion of the expansion stroke and are made to escape through exhaust valve to the atmosphere. This removed of gas is accomplished during this stroke. The piston moves from B.D.C to T.D.C and the exhaust gases are driven out of the engine cylinder. This is also called scavenging.



I.V. = Inlet Valve, E. V. = Exhaust Valve, E.C. = Engine Cylinder, C.R. = Connecting Rod, C = Crank, S. P. = Spark Plug

Figure 3.1: Four stroke Petrol Engine

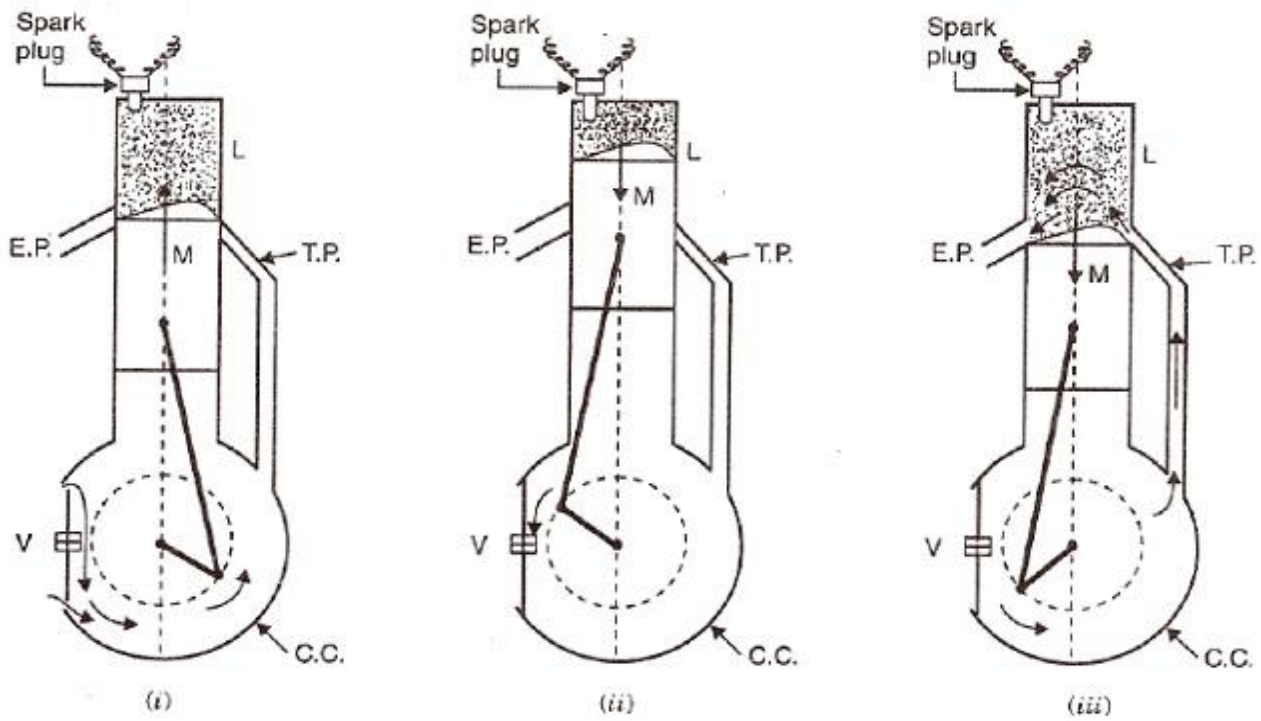
(B) WORKING OF TWO STROKE PETROL ENGINE:

In 1878, Dugald-clerk, a British engineer introduced a cycle which could be completed in two strokes of piston rather than four strokes as is the case with the four stroke cycle engines. The engines using this cycle were called two stroke cycle engines. In this engine suction and exhaust strokes are eliminated. In two stroke engine, the working cycle is completed into two stroke of the piston or one revolution of crankshaft. In two stroke engine the intake and compression processes are completed during the inward stroke and Expansion & exhaust process during the outward stroke. Here *instead of valves, ports are used. The exhaust gases are driven out from engine cylinder by the fresh change of fuel entering the cylinder nearly at the end of the working stroke*.

Fig. 2 shows a two stroke petrol engine (used in scooters, motor cycles etc.). The *cylinder L* is connected to a closed *crank chamber* C.C. During the upward stroke of the piston *M*, the gases in *L* are compressed and at the same time fresh air and fuel (petrol) mixture enters the crank chamber through the valve *V*. When the piston moves downwards, *V* closes and the mixture in the crank chamber is compressed. Refer Fig. 2 (*i*) the piston is moving upwards and is compressing an explosive change which has previously been supplied to *L*. Ignition takes place at the end of the stroke. The piston then travels downwards due to expansion of the gases [Fig. 2 (*ii*)] and near the end of this stroke the piston uncovers the *exhaust port* (E.P.) and the burnt exhaust gases escape through this port [Fig. 2 (*iii*)]. The *transfer port* (T.P.) then is uncovered immediately, and the compressed

charge from the crank chamber flows into the cylinder and is deflected upwards by the hump provided on the head of the piston. It may be noted that the incoming air petrol mixture helps the removal of gases from the engine-cylinder; if, in case these exhaust gases do not leave the cylinder, the fresh charge gets diluted and efficiency of the engine will decrease. The piston then again starts moving from bottom dead centre (B.D.C.) to top dead centre (T.D.C.) and the charge gets compressed when E.P. (exhaust port) and T.P. are covered by the piston ; thus the cycle is repeated.

The power obtained from a two-stroke cycle engine is *theoretically twice* the power obtainable from a four-stroke cycle engine.



L = Cylinder, E. P. = Exhaust Port, T. P. = Transfer Port, V = Valve, C. C. = Crank Chamber

Fig 3.2: Two stroke Petrol Engine

CONSTRUCTION DETAILS:

1. **Cylinder:** It is a cylindrical vessel or space in which the piston makes a reciprocating produces.
2. **Piston:** It is a cylindrical component fitted into the cylinder forming the moving boundary of combustion system. It fits in cylinder perfectly.
3. **Combustion Chamber:** It is the space enclosed in the upper part of cylinder, by the cylinder head & the piston top during combustion process.
4. **Inlet Manifold:** The pipe which connects the intake system to the inlet valve of engine.

5. **Exhaust Manifold:** The pipe which connects the exhaust system to the exhaust valve of engine.
6. **Inlet / Exhaust Valves:** They are provided on the cylinder head to head to regulate the charge coming into or going out of the chamber.
7. **Spark Plug:** It is used to initiate the combustion process in S.I engines.
8. **Connected Rod:** It connects piston & the crank shaft.
9. **Crank shaft:** It converts the reciprocating motion of the piston into useful rotary motion of output shaft.
10. **Gudgeon pins:** It forms a link between connection rod and the piston.
11. **Cam shaft:** It controls the opening & closing of the valves.
12. **Cam:** They open the valves at the correct tunes.
13. **Carburettor:** Used in S.I engine for atomizing & vaporizing and mixture it with air in varying proportion.

Assignment: Draw P-V and T-S diagram of Otto Cycle

Exp. No. 3	**Title:** Study of Two Stroke & Four Stroke Petrol Engine.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**

Experiment No. 4

AIM: Study of Two Stroke & Four Stroke Diesel Engine.

APPARATUS USED: Model of two stroke & four stroke diesel engine.

THEORY:

(A) FOUR STROKE (C.I.) ENGINE:

In four strokes C.I. Engine compression ratio is from 16 to 20. During suction stroke air is inducted. In C.I. engines high pressure. Fuel pump and injectors are provided to inject the fuel into combustion chamber and ignition chamber system is not necessary. The various stroke of a four stroke (Diesel) cycle engine are given below:-

1. **Suction:** During suction stroke, air is inducted through inlet valve.
2. **Compression:** The air inducted is compressed into the clearance volume.
3. **Expansion:** Fuel injection starts nearly at the end of the compression stroke. The rate of injection is such that the combustion maintains the pressure constant inspired of piston movement on its expansion stroke increasing the volume. After injection of fuel, the products of combustion chamber expand.
4. **Exhaust:** The piston travelling from BDC to TDC pushes out the products of combustion out of cylinder.

(B) Two Stroke (C.I.) Engine:

In two stroke engines, the cycle is completed in one revolution of the crankshaft. In 2-stroke engine, the filling process is accomplished by the charge compressed in crankcase or by a blower. The induction of compressed charge moves out of the exhaust ports. Therefore, no piston strokes are required for these 2 operations. Two strokes are sufficient to complete the cycle one for compressing the fresh charge and other for expansion or power stroke.

1. **Compression:** The air or charge is inducted into the crankcase through the spring loaded inlet valve when the pressure in crankcase is reduced due to upward motion of piston.
2. **Expansion:** During this, the charge in the crankcase is compressed. At the end the piston uncovers the exhaust ports and cylinder pressure drops to the atmospheric pressure. Further movement of piston opens the transfer ports, permitting the slightest compressed charge in the crankcase to enter the engine cylinder.

CONSTRUCTION DETAILS:

1. **Cylinder:** In it the piston makes a reciprocating process motion.
2. **Piston:** It is a cylindrical component fitted into the cylinder forming the moving boundary of the combustion system. It fits into cylinder.
3. **Combustion Chamber:** The space enclosed in the upper part of the cylinder, by the head and the piston top during the combustion process.
4. **Inlet/ Outlet Ports:** They are provided on the side of cylinder to regulate the charge coming in and out of cylinder.
5. **Fuel Injector:** It injects the fuel in combustion chamber to initiate combustion process for power stroke.
6. **Connecting Rod:** It interconnects crank shaft and the piston.
7. **Fly Wheel:** The net torque imparted to the crankshaft during one complete cycle of operation of the engine fluctuates, causing change in angular velocity of shaft. In order to achieve uniform torque an internal mass is attached to the output shaft & this is called as fly wheel.

Assignment: Draw P-V and T-S diagram of Diesel Cycle

Exp. No. 4	**Title:** Study of Two Stroke & Four Stroke Diesel Engine.
Name of Student:	
Roll No.:	
Date of Experiment:	
Date of Submission:	
Signature of Teacher with Date of Check	**SEAL**