Varuvan Vadivelan Institute of Technology

Dharmapuri – 636 703

LAB MANUAL

Regulation : 2013

Branch : *B.E.* - Mechanical Engineering

Year & Semester: II Year / IV Semester

ME6412 -THERMAL ENGINEERING LABORATORY - I

GENERAL INSTRUCTION

- All the students are instructed to wear protective **uniform, shoes** & **identity card** before entering into the laboratory.

- Before starting the exercise, students should have a clear idea about the principal of that exercise.

- All the students are advised to come with completed record and corrected observation book of previous experiment.

- Don't operate any instrument without getting concerned staff member's prior permission.

- All the machineries/equipment/instrument are highly valuable. Hence handle them carefully, to avoid fine for any breakage.

- One student form each batch should put his/her signature during receiving the instrument in instrument issue register.

ANNA UNIVERSITY: CHENNAI
REGULATION 2013

ME6412 THERMAL ENGINEERING LABORATORY –I

OBJECTIVES:

- To study the value timing P-v diagram and performance of IC Engines
- To Study the characteristics of fuels/Lubricates used in IC Engines
- To study the Performance of steam generator/ turbine

LIST OF EXPERIMENTS

A. I.C. ENGINE LAB 30

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Performance Test on 4 –stroke Diesel Engine.
4. Heat Balance Test on 4 –stroke Diesel Engine.
5. Morse Test on Multi-cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of Flash Point and Fire Point of various fuels / lubricants.

B. STEAM LAB 15

1. Study on Steam Generators and Turbines.
2. Performance and Energy Balance Test on a Steam Generator.
3. Performance and Energy Balance Test on Steam Turbine.

TOTAL: 45 PERIODS

INDEX

EXP. NO	DATE	NAME OF THE EXPERIMENT	SIGNATURE OF THE STAFF	REMARKS
01		DETERMINATION OF FLASH AND FIRE POINTS FOR GIVEN OIL USING OPEN CUP APPARATUS		
02		PORT TIMING DIAGRAM FOR TWO STROKE PETROL ENGINE		
03		VALVE TIMING DIAGRAM FOR FOUR STROKE DIESEL ENGINE		
04		ACTUAL P-v DIAGRAM FOR FOUR STROKE DIESEL ENGINE		
05		ACTUAL P-v DIAGRAM FOR TWO STROKE PETROL ENGINE		
06		PERFOMANCE TEST ON FOUR STROKE SINGLE CYLINDER DIESEL ENGINE		
07		HEAT BALANCE SHEET TEST ON SINGLE CYLINDER DIESEL ENGINE		
08		MORSE TEST ON MULTI CYLINDER PETROL ENGINE		

ENGINE & WORKING PRINCIPLES

A heat engine is a machine, which converts heat energy into mechanical energy. The combustion of fuel such as coal, petrol, and diesel generates heat. This heat is supplied to a working substance at high temperature. By the expansion of this substance in suitable machines, heat energy is converted into useful work.

Heat engines can be further divided into two types:

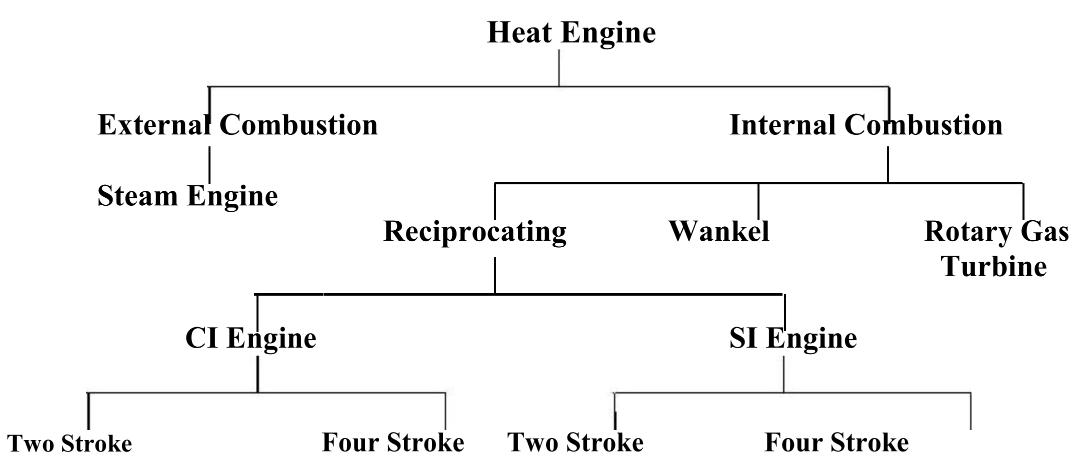
(i) External combustion and

(ii) Internal combustion.

In a steam engine the combustion of fuel takes place outside the engine and the steam thus formed is used to run the engine. Thus, it is known as external combustion engine.

In the case of internal combustion engine, the combustion of fuel takes place inside the engine cylinder itself.

Types of Heat Engines:



Spark Ignition (Carburetor Type) IC Engine

In this engine liquid fuel is atomized, vaporized and mixed with air in correct proportion before being taken to the engine cylinder through the intake manifolds. The ignition of the mixture is caused by an electric spark and is known as spark ignition.

Compression Ignition (Diesel Type) IC Engine

In this only the liquid fuel is injected in the cylinder under high pressure.

Constructional Features of IC Engine:

The cross section of IC engine is shown in Fig. 1. A brief description of these parts is given below.

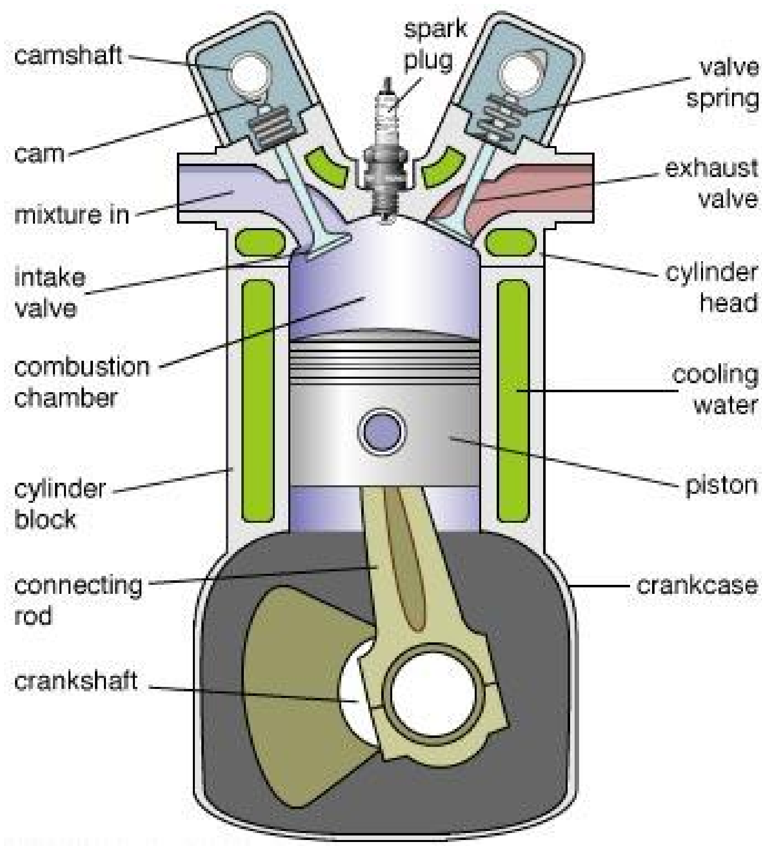


Fig. 1 Cross-section of a diesel engine

Cylinder:

The cylinder of an IC engine constitutes the basic and supporting portion of the engine power unit. Its major function is to provide space in which the piston can operate to draw in the fuel mixture or air (depending upon spark ignition or compression ignition), compress it, allow it to expand and thus generate power. The cylinder is usually made of high-grade cast iron. In some cases, to give greater strength and wear resistance with less weight, chromium, nickel and molybdenum are added to the cast iron.

Piston:

The piston of an engine is the first part to begin movement and to transmit power to the crankshaft as a result of the pressure and energy generated by the combustion of the fuel. The piston is closed at one end and open on the other end to permit direct attachment of the connecting rod and its free action.

The materials used for pistons are grey cast iron, cast steel and aluminum alloy. However, the modern trend is to use only aluminum alloy pistons in the tractor engine.

Piston Rings:

These are made of cast iron on account of their ability to retain bearing qualities and elasticity indefinitely. The primary function of the piston rings is to retain compression and at the same time reduce the cylinder wall and piston wall contact area to a minimum, thus reducing friction losses and excessive wear.

Compression rings are usually plain one-piece rings and are always placed in the grooves nearest the piston head. Oil rings are grooved or slotted and are located either in the lowest groove above the piston pin or in a groove near the piston skirt. Their function is to control the distribution of the lubricating oil to the cylinder and piston surface in order to prevent unnecessary or excessive oil consumption ion.

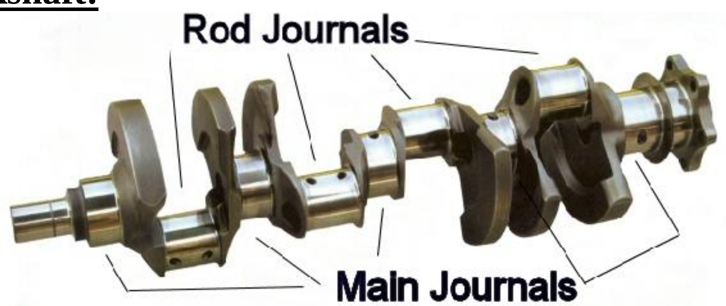
Piston Pin:

The connecting rod is connected to the piston through the piston pin. It is made of case hardened alloy steel with precision finish. There are three different methods to connect the piston to the connecting rod.

Connecting Rod:

This is the connection between the piston and crankshaft. The end connecting the piston is known as small end and the other end is known as big end. The big end has two halves of a bearing bolted together. The connecting rod is made of drop forged steel and the section is of the I-beam type.

Crankshaft:



This is connected to the piston through the connecting rod and converts the linear motion of the piston into the rotational motion of the flywheel. The journals of the crankshaft are supported on main bearings, housed in the crankcase. Counter-weights and the flywheel bolted to the crankshaft help in the smooth running of the engine.

Engine Bearings:

The crankshaft and camshaft are supported on anti-friction bearings. These bearings must be capable of withstanding high speed, heavy load and high temperatures. Normally, cadmium, silver or copper lead is coated on a steel back to give the above characteristics. For single cylinder vertical/horizontal engines, the present trend is to use ball bearings in place of main bearings of the thin shell type.

Valves:

To allow the air to enter into the cylinder or the exhaust, gases to escape from the cylinder, valves are provided, known as inlet and exhaust valves respectively. The valves are mounted either on the cylinder head or on the cylinder block.

Camshaft:

The valves are operated by the action of the camshaft, which has separate cams for the inlet, and exhaust valves. The cam lifts the valve against the pressure of the spring and as soon as it changes position the spring closes the valve. The cam gets drive through either the gear or sprocket and chain system from the crankshaft. It rotates at half the speed of the camshaft.

Flywheel:

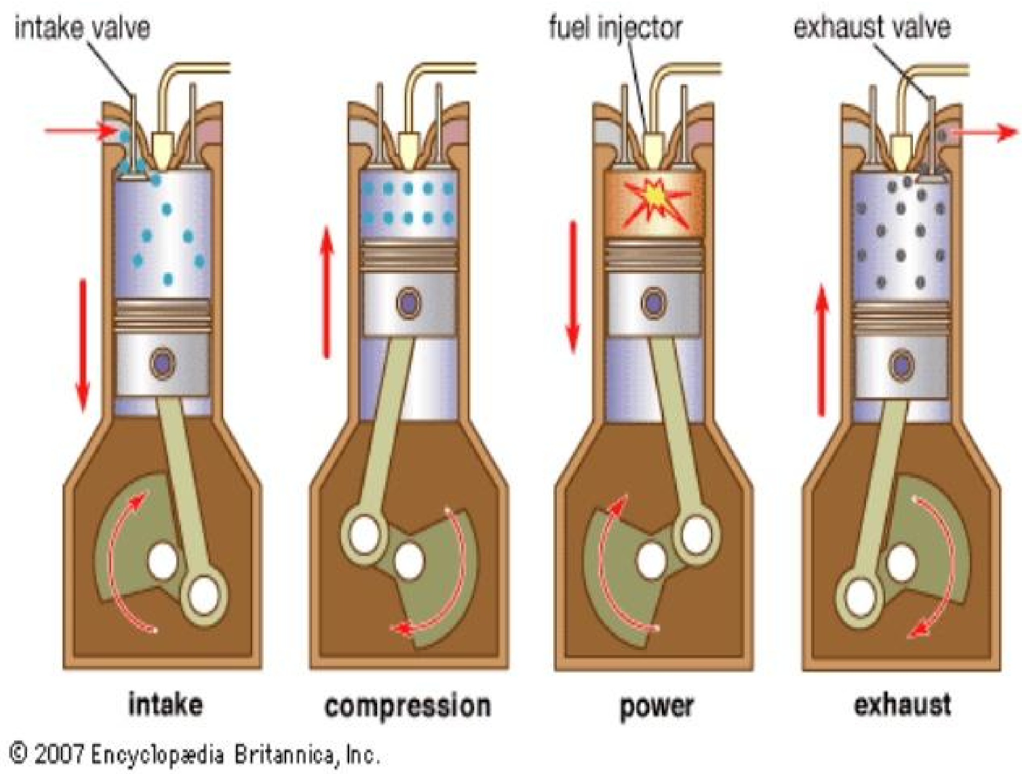
This is usually made of cast iron and its primary function is to maintain uniform engine speed by carrying the crankshaft through the intervals when it is not receiving power from a piston. The size of the flywheel varies with the number of cylinders and the type and size of the engine. It also helps in balancing rotating masses.

PRINCIPLES OF OPERATION OF IC ENGINES:

FOUR-STROKE CYCLE DIESEL ENGINE

In four-stroke cycle engines there are four strokes completing two revolutions of the crankshaft. These are respectively, the suction, compression, power and exhaust strokes. In Fig. 3, the piston is shown descending on its suction stroke. Only pure air is drawn into the cylinder during this stroke through the inlet valve, whereas, the exhaust valve is closed. These valves can be operated by the cam, push rod and rocker arm. The next stroke is the compression stroke in which the piston moves up with both the valves remaining closed.

The air, which has been drawn into the cylinder during the suction stroke, is progressively com-pressed as the piston ascends. The compression ratio usually varies from 14:1 to 22:1.

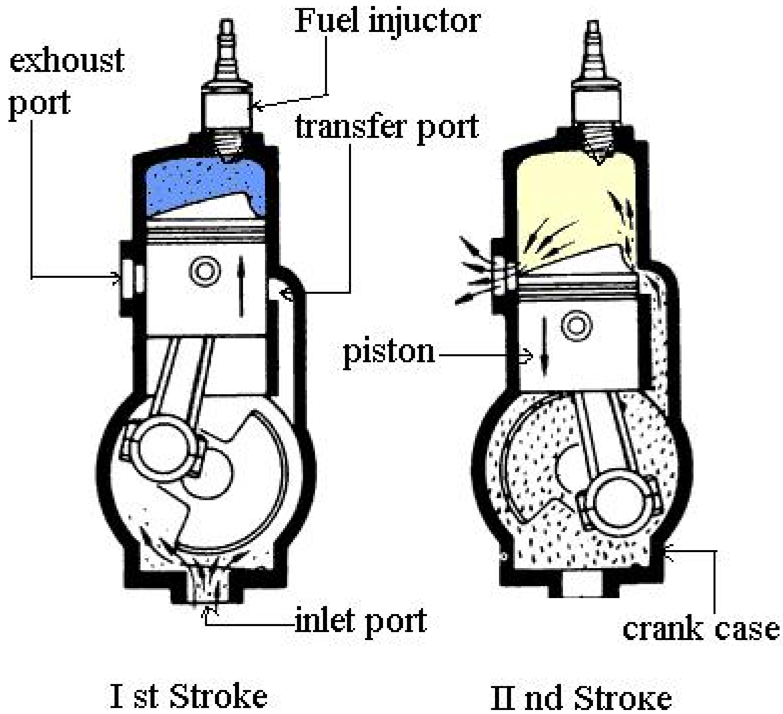


During the fuel injection period, the piston reaches the end of its compression stroke and commences to return on its third consecutive stroke, viz., power stroke. During this stroke the hot products of combustion consisting chiefly of carbon dioxide, together with the nitrogen left from the compressed air expand, thus forcing the piston downward. This is only the working stroke of the cylinder.

TWO-STROKE CYCLE DIESEL ENGINE:

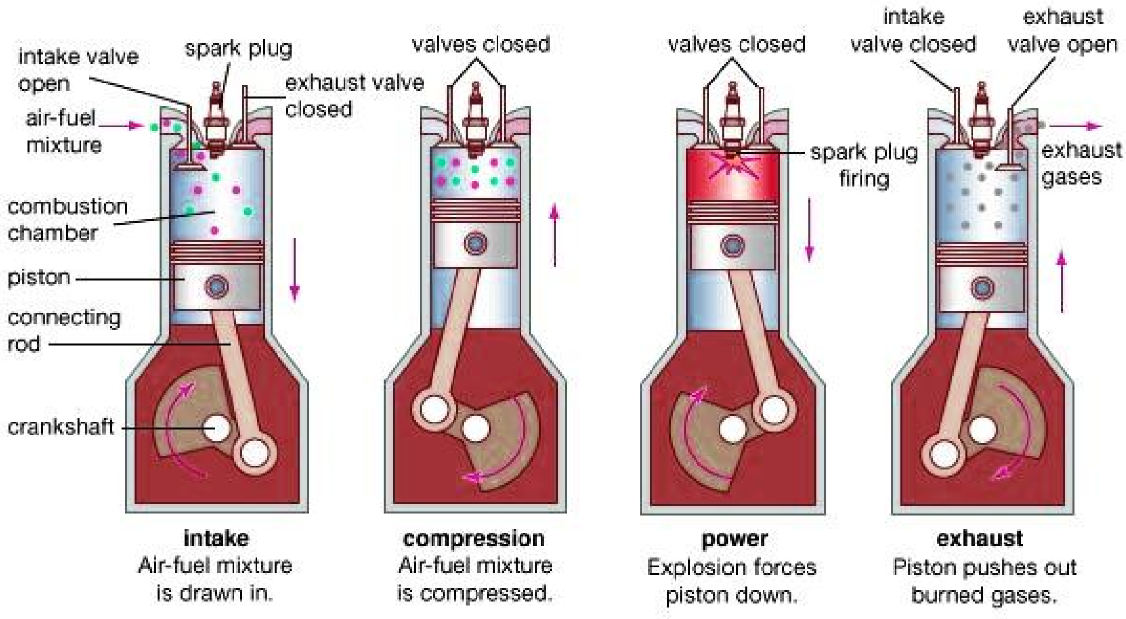
The cycle of the four-stroke of the piston (the suction, compression, power and exhaust strokes) is completed only in two strokes in the case of a two-stroke engine. The air is drawn into the crankcase due to the suction created by the upward stroke of the piston.

On the down stroke of the piston it is compressed in the crankcase, The compression pressure is usually very low, being just sufficient to enable the air to flow into the cylinder through the transfer port when the piston reaches near the bottom of its down stroke.



FOUR-STROKE SPARK IGNITION ENGINE

In this gasoline is mixed with air, broken up into a mist and partially vaporized in a carburetor (Fig. 5). The mixture is then sucked into the cylinder. There it is compressed by the upward movement of the piston and is ignited by an electric spark. When the mixture is burned, the resulting heat causes the gases to expand. The expanding gases exert a pressure on the piston (power stroke). The exhaust gases escape in the next upward movement of the piston. The strokes are similar to those discussed under four-stroke diesel engines. The various temperatures and pressures are shown in Fig. 6. The compression ratio varies from 4:1 to 8:1 and the air-fuel mixture from 10:1 to 20:1.



TWO-STROKE CYCLE PETROL ENGINE

The two-cycle carburetor type engine makes use of an airtight crankcase for partially compressing the air-fuel mixture (Fig. 6). As the piston travels down, the mixture previously drawn into the crankcase is partially compressed. As the piston nears the bottom of the stroke, it uncovers the exhaust and intake ports. The exhaust flows out, reducing the pressure in the cylinder. When the pressure in the combustion chamber is lower than the pressure in the crankcase through the port openings to the combustion chamber, the incoming mixture is deflected upward by a baffle on the piston. As the piston moves up, it compresses the mixture above and draws into the crankcase below a new air-fuel mixture.

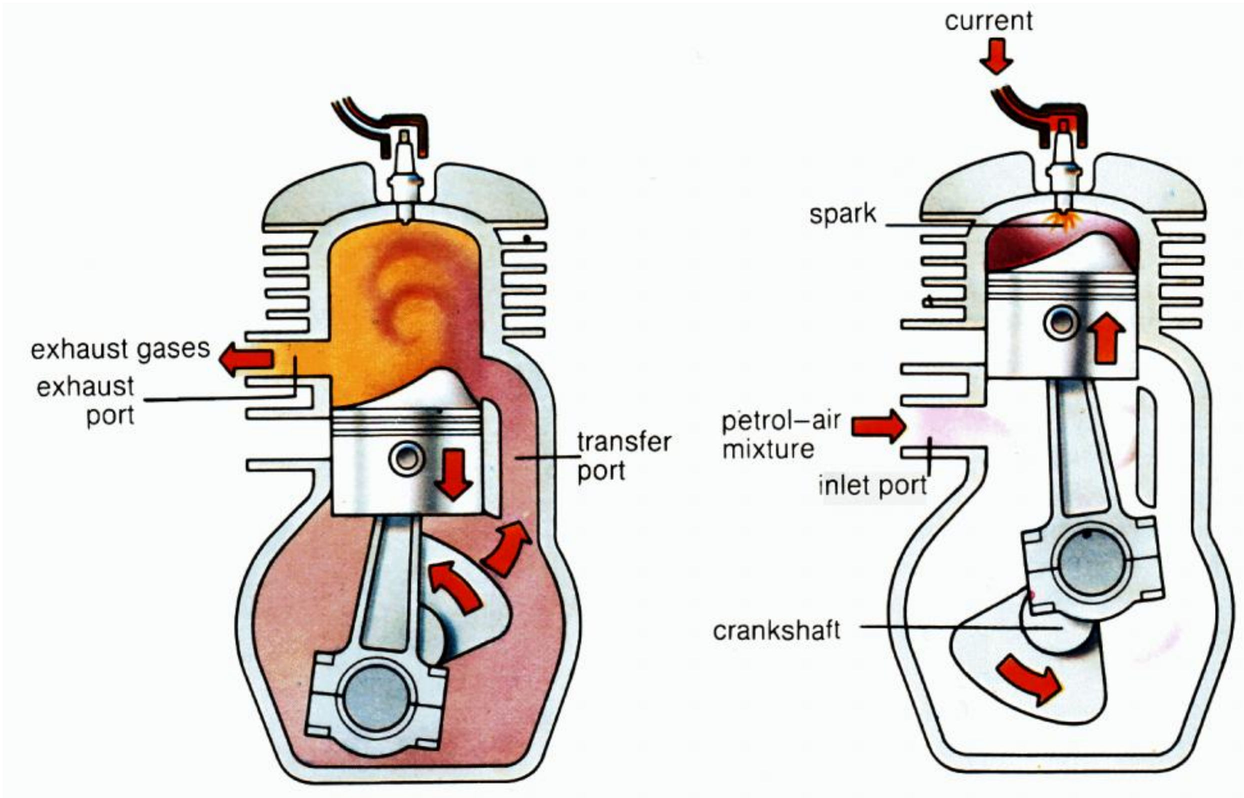


Fig. 6 Principle of operation of two stroke petrol engine

The, two-stroke cycle engine can be easily identified by the air-fuel mixture valve attached to the crankcase and the exhaust Port located at the bottom of the cylinder.

EX. NO : 1

DATE :

DETERMINATION OF FLASH AND FIRE POINTS FOR GIVEN OIL USING OPEN CUP APPARATUS

AIM:

To determine the flash and fire point of the given oil using open cup apparatus

APPRATUS REQUIRED:

- Open Cup flash point apparatus
- Thermometer

PROCEDURE:

1. The fuel under examination is filled up to the mark in the oil cup and then heated by heating the water bath by burner.
2. Stirrer is worked between tests at a rate of about 1 to 2 revolution per seconds.
3. Heat is applied so as the raise the oil temperature by about 5°C per minutes.
4. At every 10°C raise of temperature flame is introduced for a moment by working the shuffle.
5. The temperature at which a testing flash a combination of a weak sound and light appears is noted and is the flash points.
6. The heating is continued thereafter and the test flame is applied as before.
7. When the oil ignites and continued to burn for a at least 5 seconds the temperature reading is noted and is five points.

TABULATION: (FLASH AND FIRE POINTS)

GIVEN FUEL = SAE 20-40W

SERIAL NO	**TEMPERATURE (°C)**	**OBSERVED FLASH POINT *(YES/NO)***	**OBSERVED FIRE POINT *(YES/NO)***
01			
02			
03			
04			
05			
06			
07			

RESULT:

Thus the flash and fire point of the given oil is found out experimentally

Flash point =……………………………………………

Fire point =……………………………………………

EX. NO : 2

DATE :

PORT TIMING DIAGRAM FOR TWO STROKE PETROL ENGINE

AIM:

To draw the port timing diagram for the given two stroke diesel engine

APPRATUS REQUIRED:

1. Measuring tape

FORMULA USED:

1 .REQUIRED ANGLE = (Distance X 360°) / (Circumference of the Flywheel)

- **DISTANCE =** Distance of the port opening or closing position marked on flywheel with respect to their dead centre.
- **CIRCUMFERENCE OF THE FLYWHEEL** = 62 cm

PROCEDURE:

1. First the TDC and BDC of the engine are found correctly by rotating the flywheel and the positions are marked on flywheel.
2. Now the circumference of the flywheel is found by using the measuring tape.
3. The flywheel is rotated and the point at which the transfer port starts opening is found out it is position is marked in the flywheel.
4. Similarly position at which it closes is also found out.
5. The distance are measured by using thread with respect to their dead centre and in to angles.
6. The same procedure is respected for the exhaust port also.

TABULATION :(PORT TIMING DIAGRAM FOR TWO STROKE PETROL ENGINE)

EVENTS	DISTANCE FROM THEIR RESPECTIVE DEAD CENTRE IN 'CM'	PORT OPENING PERIOD IN 'DEGREES'
Exhaust Port Open **[EPO]**		
Exhaust Port Close **[EPC]**		
Transfer Port Open **[TPO]**		
Transfer Port Close **[TPC]**		

RESULT:

Thus the port timing diagram for the given two stroke petrol engine found out and it is drawn

Transfer Port Open at ___________ degree

Transfer Port Close at _____________ degree

Exhaust Port Open at _____________ degree

Exhaust Port Close at _____________ degree

EX. NO : 3

DATE :

VALVE TIMING DIAGRAM FOR FOUR STROKE DIESEL ENGINE

AIM:

To draw the valve timing diagram for the given four stroke diesel engine.

APPRATUS REQUIRED:

1. Measuring tape

FORMULA USED:

1. REQUIRED ANGLE = (Distance X 360°) / (Circumference of the Flywheel)

- **DISTANCE =** Distance of the valve opening or closing position marked on flywheel with respect to their dead centre
- **CIRCUMFERENCE OF THE FLYWHEEL** = 124cm

PROCEDURE:

1. First the TDC and BDC of the engine are found correctly by rotating the flywheel and the positions are marked on flywheel.
2. Now the circumference of the flywheel is found by using the measuring tape.
3. The flywheel is rotated and the point at which the inlet valve starts opening is found out it is position is marked in the flywheel.
4. Similarly position at which it closes is also found out.
5. The distance are measured by using thread with respect to their dead centre and in to angles.
6. The same procedure is respected for the exhaust valve also.

TABULATION :(VALVE TIMING DIAGRAM)

EVENTS	DISTANCE FROM THEIR RESPECTIVE DEAD CENTRE IN 'CM'	VALVE OPENING PERIOD IN 'DEGREES'
Inlet Valve Open **[IVO]**		
Inlet Valve Close **[IVC]**		
Exhaust Valve Open **[EVO]**		
Exhaust Valve Close **[EVC]**		

RESULT:

Thus the valve timing diagram for the given four stroke diesel engine found out and it is drawn

Inlet Valve Open at ____________ degree

Inlet Valve close at ____________ degree

Exhaust Valve Open at ____________ degree

Exhaust Valve Close at ____________ degree

EX. NO : 4

DATE :

ACTUAL P-v DIAGRAM OF TWO STROKE PETROL ENGINE

AIM:

To diagram the Actual PV diagram for the given two stroke petrol engine.

APPRATUS REQUIRED:

1. Measuring tape

FORMULA USED:

1 .REQUIRED ANGLE = (Distance X 360°) / (Circumference of the Flywheel)

- **DISTANCE =** Distance of the port opening or closing position marked on flywheel with respect to their dead centre.
- **CIRCUMFERENCE OF THE FLYWHEEL** = **62** cm

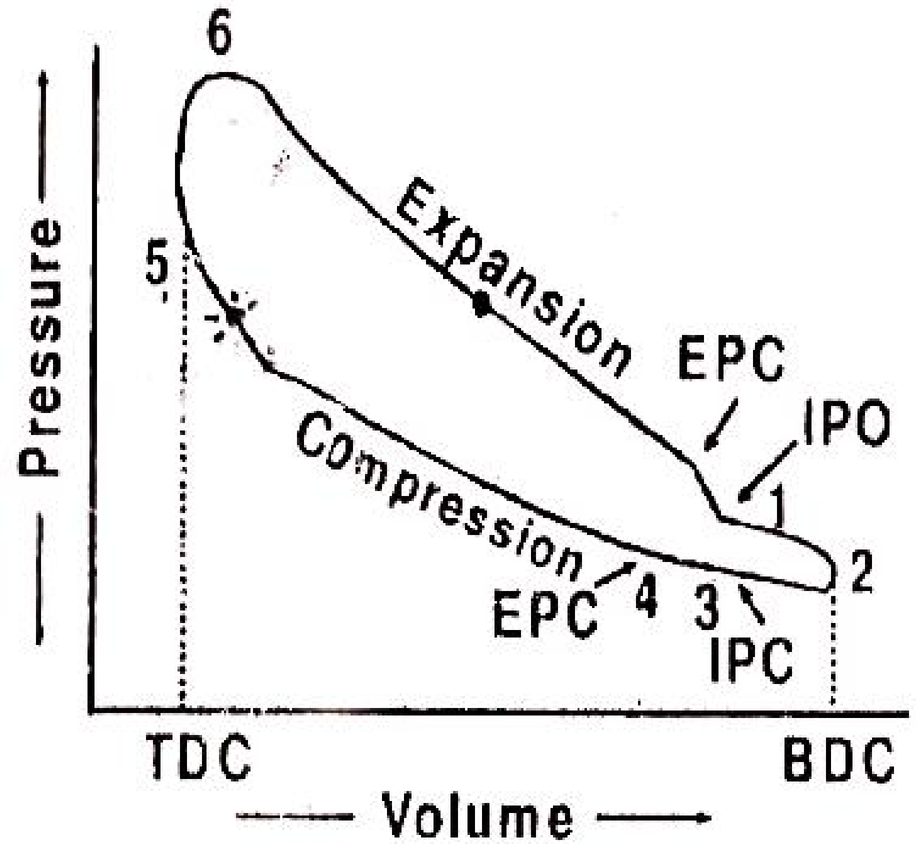
PROCEDURE:

1. First the TDC and BDC of the engine are found correctly by rotating the flywheel and the positions are marked on flywheel.
2. Now the circumference of the flywheel is found by using the measuring tape.
3. The piston moves upward stroke at the time air and fuel mixture gases in compressed and the at the same time fresh air and fuel mixture enters the crank chamber.
4. The piston is moving downwards due to expansion of the gases and the burnt exhaust gases escape through exhaust port.
5. The transfer port then is uncovered immediately and the compressed charge from the crank chamber.
6. The piston the again starts moving from BDC to TDC. Thus the cycle is repeated.

TABULATION: (ACTUAL P-v DIAGRAM OF TWO STROKE PETROL ENGINE)

EVENTS	DISTANCE FROM THEIR RESPECTIVE DEAD CENTRE IN 'CM'	PORT OPENING PERIOD IN 'DEGREES'
Exhaust Port Open **[EPO]**		
Exhaust Port Close **[EPC]**		
Transfer Port Open **[TPO]**		
Transfer Port Close **[TPC]**		

Model P-v diagram:



Indicator Diagram for a Two Stroke Cycle Petrol Engine.

RESULT:

Thus the actual P-v diagram for given two stroke petrol engine is drawn.

EX. NO : 5

DATE :

ACTUAL P-v DIAGRAM OF FOUR STROKE DIESEL ENGINE

AIM:

To diagram the Actual P-v diagram for the given four stroke Diesel engine.

APPRATUS REQUIRED:

1. Measuring tape
2. Chalk piece

FORMULA USED:

1. **REQUIRED ANGLE = (Distance X 360°) / (Circumference of the Flywheel)**
   - **DISTANCE =** Distance of the valve opening or closing position marked on flywheel with respect to their dead centre
   - **CIRCUMFERENCE OF THE FLYWHEEL** = 124cm

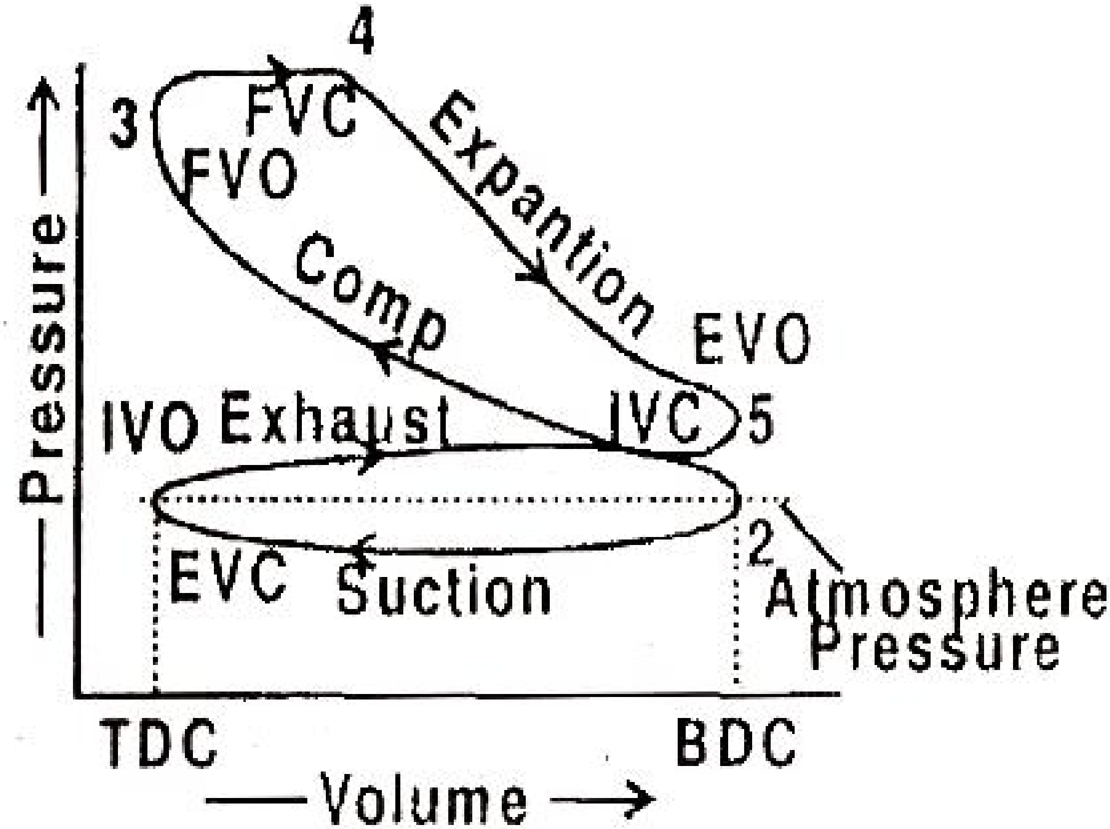
PROCEDURE:

1. Valves are opened and closed by cam mechanism.
2. Valves will balances on its seat are closed abrupt.
3. Opening or closed of valves spread over a certain crank angle
4. Inlet valve open before Top Dead Center (approx).
5. Inlet valve close before Bottom Dead Center (approx) to take advantage of rapidly moving gases.
6. Ignition occurs before Top Dead Center (approx).This to allow the time delay between the spark and commencement of combustion.
7. Exhaust valve open at Bottom Dead Center (approx), else pressure will rise enormously and the work required expecting the gas will increase.
8. Exhaust valve close at Top Dead Center (approx) this is to increases the volumetric efficiency.

TABULATION :(ACTUAL P-v DIAGRAM OF FOUR STROKE DIESEL ENGINE)

EVENTS	DISTANCE FROM THEIR RESPECTIVE DEAD CENTRE IN 'CM'	VALVE OPENING PERIOD IN 'DEGREES'
Inlet Valve Open **[IVO]**		
Inlet Valve Close **[IVC]**		
Exhaust Valve Open **[EVO]**		
Exhaust Valve Close **[EVC]**		

Model P-v diagram:



Indicator diagram for a Four Stroke Cycle Diesel Engines.

RESULT:

Thus the actual P-v diagram for given four stroke diesel engine is drawn.

EX. NO : 6

DATE :

PERFORMANCE TEST OF FOUR STROKE SINGLE CYLINDER DIESEL ENGINE

AIM

To find the load characteristics of four stroke single cylinder diesel engine

APPRATUS REQUIRED:

1. Stop watch.
2. Dead weights

FORMULA USED:

1. **BRAKE POWER:**

$$\mathbf{BP} = \frac{2\Pi NT}{60} \quad \text{'KW'}$$

Where,

N=Engine speed in rpm
T=Torque = **W*Re**
Re = Brake drum radius =0.16m
W= Net load in N = ((W1-W2)*9.81)

2. **TOTAL FUEL CONSUMPTION:**

$$\mathbf{T.F.C} = \frac{CC}{\mathbf{Tf}} \times \textbf{specific gravity} \times \frac{\mathbf{3600}}{1000}$$

Where,

T_f = Time taken to consume 10cc of fuel in seconds
CC = Amount of fuel consumption measured in cc
Specific gravity=0.86 for diesel

3. SPECIFIC FUEL CONSUMPTION:

$$\textbf{S.F.C} = \frac{\text{TFC}}{\text{Brake power}} \quad \text{'kg/kw-hr'}$$

4. FRICTIONAL POWER:

F.P= 35% to 40% of brake power

5. INDICATED POWER:

I.P= Brake power (BP) + Friction power (FP) 'kw'

6. MECHANICAL EFFICIENCY:

$$\eta_{mech} = \frac{\text{Brake power}}{\text{indicated power}} \times 100 \quad \%$$

7. INDICATED THERMAL EFFICIENCY:

$$\eta_{IT} = \frac{(IP \times 3600)}{(TFC \times CV)} \times 100 \quad \%$$

Where,

CV = Calorific Value of fuel in kJ/kg- 42,000 KJ/Kg for Diesel.

TFC = Total fuel consumption in kg/hr

8. BRAKE THERMAL EFFICIENCY:

$$\eta_{IT} = \frac{(BP \times 3600)}{(TFC \times CV)} \times 100 \quad \%$$

PROCEDURE:

1. The fuel in first filled in the tank.
2. Then the cooling arrangements are made.
3. Before starting the engine the break drum circumference is noted.
4. Before starting check and assure that there is no load on the weight.
5. Now the engine is started and the time taken for 10cc of fuel consumption is noted with help of a stop watch. This reading corresponds to load condition.
6. Now place weight in the weight hanger and the above mentioned readings. The spring balance reading is also noted down.
7. The above procedure is repeated for various loads the readings are tabulated.
8. The calculations are done and various graphs are plotted.

GRAPHS:

1. BP vs T.F.C
2. BP vs S.F.C
3. BP vs η_{mech}
4. BP vs η_{IT}
5. BP vs η_{BT}

TABULATION: (PERFORMANCE TEST OF FOUR STROKE SINGLE CYLINDER DIESEL ENGINE)

S. NO	Dead weight (W_1)	Rope weight (W_2)	Net load (W_1-W_2+1.5)	Time taken for 10cc of fuel consumption (T_f)	Brake power KW	Frictional power KW	Indicated power KW	T.F.C Kg/hr	S.F.C Kg/kw-hr	Brake thermal efficiency η_{BT}	Indicated thermal efficiency η_{IT}	Mechanical efficiency η_{mech}
1												
2												
3												

RESULT:

Thus the load test on four stroke single cylinder diesel engine is performed and its load characteristics are obtained.

EX. NO : 7

DATE :

HEAT BALANCE SHEET TEST ON FOUR STROKE SINGLE CYLINDER DIESEL ENGINE

AIM:

To conduct a test on single cylinder diesel engine and draw the heat balance sheet at various load.

APPRATUS REQUIRED:

1. Stop watch
2. Dead weights

FORMULA USED:

1. **HEAT SUPPLIED TO ENGINE:**

$$Q_s = (TFC * CV)$$

Where,

TFC = Total fuel consumption kg/min
CV = Calorific value of fuel =43000 kJ/kg

2. TOTAL FUEL CONSUMPTION

$$T.F.C = \frac{CC}{Tf} \times \text{specific gravity} \times \frac{3600}{1000} \text{ 'kg/hr'}$$

Where,

T_f = Time taken to consume 10cc of fuel in seconds
CC = Amount of fuel consumption measured in 'cc'
Specific gravity for diesel =0.86

3. HEAT EQUIVALENT TO BREAK POWER

$$Q_{BP} = B.P \times 60 \text{ 'KJ/min'}$$

4. **HEAT CARRIED AWAY BY THE COOLING WATER (Q_W)**

$$Q_w = Mw*C_{pw}(Two-Twi) \quad \text{in KJ/min}$$

Where,

M_w = Mass of cooling water circulated in kg/min
C_{pw} = Specific heat of cooling water =4.186 kJ/kg.k
T_{wi} = Temperature of cooling water at inlet in 'K'
T_{wo} = Temperature of cooling water at outlet in 'K'

5. **MASS OF AIR ENTERING THE CYLINDER**

$$M_a=c_d \times A \times \sqrt{(2g \times h_w \times \rho_w \times \rho_a)}$$

Where,

C_d = co-efficient of discharge of orifice meter=0.67
A = area of orifice meter in m^2 = Do=25mm,
ρ_w = density of water in kg/m^3=1000
ρ_a = density of air kg/m^3 =1.23

6. **MECHANICAL EFFICIENCY:**

$$M_g= M_a+M_f$$

Where,

Ma = mass of air consumed per minute
Mf = mass of fuel consumed per minute
M_f = TFC=Total fuel consumption kg/min

7. **HEAT CARRIED AWAY BY THE EXHAAUST GAS (Qg):**

$$Q_g=M_g \times C_{pg} (T_e-T_{wi})$$

Where,

M_g = Mass of the exhaust air in kg/min

C_{pg} = Specific heat of exhaust gas=1.005 kJ/kg.k

T_e = Temperature of exhaust gas in 'K'

- T_{wi} = Room temperature in 'K'

8. UNACCOUNTED HEAT LOSSES:

$$Q_{un}=Q_s-(Q_{BP}+Q_g+Q_w) \text{ 'kJ/min'}$$

PROCEDURE:

1. From the name plate details, calculate the maximum load chat can be applied on the given engine.
2. Check the engine fuel availability, lubricant and cooling water connection.
3. Release the load on engine completely and start the engine with no load condition .allow the engine to run for few minute to attain the rated speed.
4. Apply the load from no load to required load slowly .at required load note the following.
5. Load on the engine.
6. Speed of the engine in rpm.
7. Time taken for 10cc of fuel consumption.
8. Manometer reading.
9. Temperature of cooling water at engine inlet and outlet in K.
10. Time taken for collection of cooling water.
11. Room temperature and exhaust gases temperature.

TABULATION: 1 (HEAT BALANCE SHEET TEST ON FOUR STROKE SINGLE CYLINDER DIESEL ENGINE)

S. NO	Loading			Manometer reading in 'm'			Time taken for 10 cc fuel consumption 'sec'	Time for 5 liter water collection 'sec'	Water inlet temperature °C	Water outlet temperature °C	Exhaust gas temperature °C
	Dead weight W_1	Rope weight W_2	Net load $(w_1-w_2+1.5)$	H_1	H_2	$H=H_1-H_2$					
1											
2											
3											

TABULATION: 2 (HEAT BALANCE SHEET TEST ON FOUR STROKE SINGLE CYLINDER DIESEL ENGINE)

Sl. no	Particulars	Credits KJ/min	%	Sl. no	Particulars	Debits KJ/min	%
1	Heat supplied to the engine(Qs)			1	Heat equivalent to brake power(Q_{BP})		
				2.	Heat carried away by cooling water (Q_w)		
				3	Heat carried away by exhaust gas (Q_g)		
				4	Unaccounted heat losses		
TOTAL				TOTAL			

RESULT:

Thus the load test on four stroke single cylinder diesel engine and draw the heat balance sheet at various load.

EX. NO : 8

DATE :

MORSE TEST ON MULTI CYLINDER PETROL ENGINE

AIM:

To find the frictional power and mechanical efficiency of the four stroke multi cylinder petrol engine by Morse test.

APPRATUS REQUIRED:

1. Tachometer.

FORMULA USED:

1. TOTAL BRAKE POWER (BP) = $BP_1 + BP_2 + BP_3 + BP_4$

a) ALL CYLINDERS ARE WORKING CONDITION:

$$\text{BRAKE POWER } (BP_{1234}) = \frac{2\Pi NT}{60} \text{ 'KW'}$$

Where,

N=Engine speed in rpm for all cylinder working
T=Torque = W*Re
Re = Brake drum radius in cm
W= dead weight in kg

b) First cylinder was cut-off and remaining are in working

$$\text{BRAKE POWER } (BP_{234}) = \frac{2\Pi NT}{60} \text{ 'KW'}$$

Where,

N=Engine speed in rpm for first cylinder cut-off and remaining are working

❖ **First cylinder brake power (BP_1) = $BP_{1234} - BP_{234}$ 'kW'**

ii. **Second cylinder was cut-off and remaining are in working**

BRAKE POWER (BP_{134}) $= \frac{2\Pi NT}{60}$ 'KW'

Where,

N=Engine speed in rpm for Second cylinder cut-off and remaining are working

- **Second cylinder brake power (BP_2) = BP_{1234}-BP_{134} 'kW'**

iii. Third cylinder was cut-off and remaining are in working

BRAKE POWER (BP_{124}) $= \frac{2\Pi NT}{60}$ 'KW'

Where,

N=Engine speed in rpm for Third cylinder cut-off and remaining are working

- **Third cylinder brake power (BP_3) = BP_{1234}-BP_{124} 'kW'**

iv. Fourth cylinder was cut-off and remaining are in working

BRAKE POWER (BP_{123}) $= \frac{2\Pi NT}{60}$ 'KW'

Where,

N=Engine speed in rpm for Fourth cylinder cut-off and remaining are working

- **Fourth cylinder brake power (BP_4) = BP_{1234}-BP_{123} 'kW'**

2. FRICTIONAL POWER:

- 30 % of Brake power (For petrol engine)

3. INDICATED POWER:

I.P= B.P+ F.P ‘kw’

4. MECHANICAL EFFICIENCY:

$$\eta_{mech} = \frac{BP}{IP} \times \text{‘KW’}$$

PROCEDURE:

1. Calculate maximum speed in rpm.
2. Check the engine for no load coolant supply.
3. Connect the battery terminals.
4. Ensure on position of 4 switches to spark plug.
5. Apply gradually speed is adjust throttle.
6. Now down the speed and load.
7. Connect the first spark plug and disconnect the seconds plug.
8. Repeat the same for remaining cylinder.
9. Remove load and run engine for two minutes switch off the engine and coolant close supply.

TABULATION: **(ORSE TEST ON MULTI CYLINDER PETROL ENGINE)**

SL .NO	SPEED ON THE ENGINE RPM					LOAD ON THE ENGINE	BRAKE POWER	INDICATED POWER	FRICTIONAL POWER	MECHANICAL EFFICIENCY
	All cylinder	Cut off 1	Cut off 2	Cut off 3	Cut off 4					

RESULT:

The frictional power and mechanical efficiency of the four stroke petrol engine are found out by conducting Morse test.

VIVA VOCE

1. Describe the working principle of 2-Stroke petrol Engine?
2. Describe the working principle of 4-Stroke petrol Engine?
3. What is Suction Stroke?
4. What is compression Stroke?
5. Describe Expansion / Power Stroke?
6. Describe Exhaust Stroke?
7. What are the construction details of a four stroke petrol Engine?
8. What is the main deference in 2-Stroke Petrol Engine and 4-Stroke Petrol Engine?
9. Describe the working principle of 2-Stroke Diesel Engine?
10. Describe the working principle of 4-Stroke Diesel Engine?
11. What is compression Stroke?
12. Describe Expansion / Power Stroke?
13. What are the construction details of a four stroke Diesel Engine?
14. What is the main deference in 2-Stroke Diesel Engine and 4-Stroke Diesel Engine?
15. Describe the deference in 2-stroke Diesel Engine & 2-Stroke Petrol Engine?
16. Explain the air-fuel ratio?
17. What is Injection Timing?
18. What are the methods of available for improving the performance of an engine?
19. Define the Morse test?
20. What is need of measurement of speed of an I.C. Engine?
21. What is the break power of I.C. Engines?
22. What is volumetric efficiency?
23. What is air fuel ratio in two stroke single cylinder petrol engine?
24. What is air delivery ratio in two stroke single cylinder petrol engine?
25. Explain the method of measurement of smoke by comparison method?

26. Define the friction power?
27. Define Willian's lines methods?
28. What is break power?
29. Define speed performance test on a four-stroke single – Cylinder diesel engine?
30. What is Air rate and A/F ratio in a four-stroke single – Cylinder diesel engine?
31. What is combustion phenomenon?
32. What is indicated power?
33. Define carburetion?
34. Define valve timing in four stroke petrol engine?
35. What is overlapping?
36. What is inlet valve?
37. What is exhaust valve?
38. What do you mean by ignition?
39. What are the various types of ignition systems that are commonly used?