DRONACHARYA
College of Engineering

LABORATORY MANUAL

B.Tech. Semester- VI

INTERNAL COMBUSTION ENGINE
Subject code: LC-ME-312G

Prepared by:
Mr. Yudhveer

Sign.: ……………………..

Checked by:
Mrs. Neha Chauhan

Sign.: ………………….

Approved by:
Name : Prof. (Dr.) Isha Malhotra

Sign.: ………………….

DEPARTMENT OF MECHANICAL ENGINEERING
DRONACHARYA COLLEGE OF ENGINEERING
KHENTAWAS, FARRUKH NAGAR, GURUGRAM (HARYANA)

Table of Contents

Vision and Mission of the Institute

Vision:

"To impart Quality Education, to give an enviable growth to seekers of learning, to groom them as World Class Engineers and Managers competent to match the expanding expectations of the Corporate World has been our ever enlarging vision extending to new horizons since the inception of Dronacharya College of Engineering."

Mission:

1. To prepare students for full and ethical participation in a diverse society and encourage lifelong learning by following the principle of 'Shiksha evam Sahayata' i.e. Education & Help.

2. To impart high-quality education, knowledge and technology through rigorous academic programs, cutting-edge research, & Industry collaborations, with a focus on producing engineers& managers who are socially responsible, globally aware, & equipped to address complex challenges.

3. Educate students in the best practices of the field as well as integrate the latest research into the academics.

4. Provide quality learning experiences through effective classroom practices, innovative teaching practices and opportunities for meaningful interactions between students and faculty.

5. To devise and implement programmes of education in technology that are relevant to the changing needs of society, in terms of breadth of diversity and depth of specialization.

Vision and Mission of the Mechanical Department

Vision:

"To become a Centre of Excellence in teaching and research in the field of Mechanical Engineering for producing skilled professionals having a zeal to serve society."

Mission:

M1: To create an environment where students can be equipped with strong fundamental concepts, various experiments and problem solving skills.

M2: To provide an exposure to emerging technologies by providing hands on experience for generating competent professionals.

M3: To promote Research and Development in the frontier areas of Mechanical Engineering and encourage students for pursuing higher education.

M4: To inculcate in students ethics, professional values, team work and leadership skills.

Programme Educational Objectives (PEOs)

PEO 1: Engineers will practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams.

PEO 2: Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, and an ability to engage in continuing professional development and life-long learning.

PEO 3: Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects affect society and the environment.

PEO 4: Promote Design, Research, and implementation of products and services in the field of Engineering through Strong Communication and Entrepreneurial Skills.

PEO 5: Re-learn and innovate in ever-changing global economic and technological environments of the 21st century.

Programme Outcomes (POs)

Over completion of the Course our graduates will have ability to

1. Apply knowledge of computing, mathematical foundations, algorithmic principles, and engineering theory in the modeling and design of systems to real-world problems (fundamental engineering analysis skills).
2. Apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.
3. Design and conduct experiments, as well as to analyze and interpret data (information retrieval skills). Practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills.
4. Analyze a problem, identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution(engineering problem solving skills).
5. Understand the appropriate codes of practice and industry standards.
6. Identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques.
7. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues.
8. Communicate effectively, both in writing and orally (speaking / writing skills).
9. Understand professional, ethical, legal, security and social issues and responsibilities (professional integrity).
10. Understand customer and user needs and the importance of considerations such as Aesthetics.
11. Use creativity to establish innovative solutions.
12. Adapt to a rapidly changing environment by having learned and applied new skills and new technologies.
13. To Significantly contribute to delivery of desired component, product, or process.
14. Formulate and solve moderately complex engineering problems, accounting for hardware/software/human interactions.
15. Recognize the importance of professional development by pursuing postgraduate studies or face competitive examinations that offer challenging and rewarding careers in computing.
16. Apply the Knowledge of management techniques which may be used to achieve engineering Objectives within that context.

Program Specific Outcomes (PSOs)

On successful completion of the Mechanical Engineering Degree programme, the Graduates shall exhibit the following:

PSO1: Apply the knowledge gained in Mechanical Engineering for design and development and manufacture of engineering systems.

PSO2: Apply the knowledge acquired to investigate research-oriented problems in mechanical engineering with due consideration for environmental and social impacts

PSO3: Use the engineering analysis and data management tools for effective management of multidisciplinary projects.

University Syllabus

1. To study the constructional details & working principles of two-stroke/ four stroke petrol engine.
2. To study the constructional detail & working of two-stroke/ four stroke diesel engine.
3. Analysis of exhaust gases from single cylinder/multi cylinder diesel/petrol engine by Orsat Apparatus.
4. To prepare heat balance sheet on multi-cylinder diesel engine/petrol engine.
5. To find the indicated horse power (IHP) on multi-cylinder petrol engine/diesel engine by Morse Test.
6. To prepare variable speed performance test of a multi-cylinder/single cylinder petrol engine/diesel engine and prepare the curves (i) bhp, ihp,fhp, vs speed (ii) volumetric efficiency & indicated specific specific fuel consumption vs speed.
7. To find fhp of a multi-cylinder diesel engine/petrol engine by Willian's line method & by motoring method.
8. To perform constant speed performance test on a single cylinder/multi-cylinder diesel engine & draw curves of (i) bhp vs fuel rate, air rate and A/F and (ii) bhp vs mep, mech efficiency & sfc.
9. To measure CO & Hydrocarbons in the exhaust of 2- stroke / 4-stroke petrol engine.
10. To find intensity of smoke from a single cylinder / multi-cylinder diesel engine.
11. To draw the scavenging characteristic curves of single cylinder petrol engine.
12. To study the effects of secondary air flow on bhp, sfc, Mech. Efficiency & emission of a two stroke petrol engine.

NOTE: At least ten experiments are to be performed in the Semester

Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

CO312.1- Understand the how to prepare the graph between bhp, ihp, fhp vs speed by using variable compression test rig.

CO312.2- Knowledge of functions of 4 stroke and two stroke engines.

CO312.3- Learn Combustion System of IC Engines with Lubrication and Cooling system.

CO312.4- Familiarization of the pollution control system.

CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16
CO312.1	3	3	3	-	2	-	3	3	3	2	-	2	3	-	-	3
CO312.2	-	2	-	-	3	3	-	-	-	2	-	3	-	-	2	3
CO312.3	-	-	3	3		2	-	-	2	-	3	-	2	3	-	-
CO312.4	3	-	2	-	2	-	2	3	-	3	-	3	-	3	2	3

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO312.1	3	2	-
CO312.2	2	3	-
CO312.3	3	2	-
CO312.4	3	2	3

Course Overview

IC engine lab courses provide students with hands-on experience in working with internal combustion engines. These courses are typically part of mechanical engineering or automotive engineering programs and aim to familiarize students with the operation, performance, and testing of internal combustion engines. The course usually begins with an introduction to the various components of an internal combustion engine, such as the cylinder block, piston, connecting rod, crankshaft, valves, and camshaft. Students learn about the functions of each component and how they work together to convert fuel into mechanical energy. Students get hands-on experience in disassembling and reassembling engines. This process helps them understand the construction and arrangement of engine parts and allows them to inspect individual components for wear and damage.

LIST OF EXPERIMENT

S. No.	Name of the Experiment	Course Outcomes
1.	To study the constructional details & working principles of two-strokepetrol/ four-stroke petrol Engine.	CO312.2
2.	To study the constructional details & working principles of two-strokeDiesel / four-stroke Diesel Engine.	CO312.1, CO312.2
3.	Analysis of exhausts gases from single-cylinder/ multi-cylinder/ petrolengine by Orsat apparatus.	CO312.3
4.	To prepare heat balance sheet on multi-cylinder diesel engine / petrol engine.	CO312.1, CO3
5.	To find the indicated horse power (IHP) on multi-cylinder diesel engine / petrol engine by Morse test.	CO312.1, CO312.2
6.	To prepare variable speed performance test of a multi-cylinder /single-cylinder petrol engine / diesel engine and prepare the curve (i) bhp, ihp, fhp Vs Speed (ii) Volumetric efficiency & indicated specific fuel consumption Vs Speed.	CO312.1, CO312.3
7.	To find fhp of multi cylinder diesel engine / petrol engine by Willian'sLine Method & Motoring Method.	CO312.2, CO312.3
8.	To perform constant speed performance test on a single-cylinder/ multi-cylinder diesel engine & draw curves of (i) bhp Vs fuel rate, air rate and A/F and (ii) bhp Vs mep, mechanical efficiency & b.s.f.c.	CO312.2, CO312.3
9.	To measure CO & Hydrocarbons in the exhaust of 2- stroke / 4-stroke petrol engine.	CO312.3
10.	To draw the scavenging characteristic curves of single cylinder petrol engine.	CO312.4

DOs and DON'Ts

DOs

1. Work deliberately and carefully.
2. Keep your work area clean.
3. Students must wear college uniform and carry their college ID.
4. Students should have separate note book for practical.
5. Students should have their own pencil, eraser, scale, along with pen and lab note book.
6. Handle the equipment /models carefully.

DON'Ts

1. Do not wander around the room, distract other students, startle other students or interfere with the laboratory experiments of others.
2. Do not eat food, drink beverages or chew gum in the laboratory.
3. Do not open any irrelevant internet sites on lab computer.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth, if possible, isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.

Emergency: Reception

Security: Main Gate

Lab assessment criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes areassessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Pre-Lab written work (this may be assessed through viva)	Complete procedure with underlined concept is properly written	Underlined conceptis written but procedure is incomplete	Not able to write conceptand procedure	Underlined conceptis not clearly understood
AC2: Program Writing/ Modeling	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied.	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied	Assigned problem is properly analyzed & correct solution designed	Assigned problem is properly analyzed
AC3: Identification & Removal of errors/ bugs	Program/solution written is readable Able to identify errors/ bugs and remove them	Able to identify errors/ bugs and remove them with little bit of guidance	Is dependent total lyon someone for identification of errors/ bugs and their removal	Unable to understand the reason for errors/ bugs even after they are explicitly pointed out Solution is not well demonstrated and implemented concept is not clearly explained
AC4:Execution & demonstration	All variants of input /output are tested, Solution is well demonstrated and implemented concept is clearly explained	All variants of input /output are not tested, However, solution is well demonstrated and implemented concept is clearly explained	Only few variants of input /output are tested,Solution is well demonstrated but implemented concept is not clearly explained	Less than 40 % of the assigned problems are well recorded with objective, design contracts and solution along with
AC5:Lab Record Assessment	All assigned problems are well recorded with objective, design constructs and solution along with Performance analysis using all variants of input and output	More than 70 % of theassigned problems are well recorded with objective, design contracts and solution along with Performance analysis is done with all variants of input and output	Less than 70 % of the assigned problems are well recorded with objective, design contracts and solution along Performance analysis is done with all variants of input andoutput	Performance analysis is done with all variants of input and output

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows:

1) All files must contain a title page followed by an index page. The files will not be signed by the faculty without an entry in the index page.

2) Student’s Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment

(ii) Pre-experiment work (as given by the faculty)

(iii) Lab assignment questions and their solutions

(iv) Test Cases (if applicable to the course)

(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.
2. Students must ensure that their lab record is regularly evaluated.

Experiment No.-1

Aim: -To Study the construction details & working principal of 2-Stroke / 4-Stroke Petrol Engine.

Apparatus: - Models of 2-Stroke / 4-Stroke Engines.

Theory: - The working Principle of Engines.

Four Stroke (S.I) 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 o□f crank rotation. The 4-Strokes are: -

Suction or Intake Stroke: - In starts at, when the piston is at top deadcentre & about to move downwards. The inlet valve is open at that time and exhaust valve is closed due to suction created by the motion of the piston towards the bottom dead centre, the charge containing air fuel mixture is drawn into the cylinder. When the piston reaches BDC the suction stroke ends and inlet valve is closed.

Compression Stroke: - The charge taken into the cylinder during suction stroke is compressed by return stroke of piston. During this stroke both the valves are closed. The mixture which fills the entire cylinder volume is now compressed into the clearance volume. At the end, the mixture is ignitedwith the help of electrode of spark plug. During the burning process the chemical energy of fuel is converted to heat energy. The pressure is increased in the end due to heat release.

Expansion Stroke: - The burnt gases escape out and the exhaust valveopens but inlet valve remaining closed the piston moves from BDC to TDC and sweeps the burnt gases out at almost atmospheric pressure. The exhaust valve gets closed at the end of this stroke. Thus, for one complete cycle of engine, there is only one power stroke while crank shaft makes 2 revolutions.

Exhaust Stroke: - During the upward motion of the piston, the exhaust valve is open and inlet valve is closed. The piston moves up in cylinder pushing out the burnt gases through the exhaust valve. As the piston reaches the TDC, again the inlet valve opens and fresh charge is taken in during next downward movement of the piston and the cycle is repeated.

2-Stroke (S.I) Engines. In a 2-Stroke engine, the filling process is accompanied by the change compressed in a crank case or by a blower. The induction of compressed chargemoves out the product of combustion through exhaust ports. Therefore, no piston stroke is required. For these 2-strokes one for compression of freshcharge and second for power stroke.

The charge conducted into the crank case through the spring loaded valve when the pressure in the crank case is reduced due to upward motion of piston during the compression stroke. After the compression & ignition expansion takes placein usual way.

During the expansion stroke the charge in crankcase is compressed. Near the end of the expansion stroke, the piston uncovers the exhaust ports and the cylinder pressure drops to atmosphere pressure as combustion produced leave the cylinder.

Construction Details

Cylinder: - It is a cylindrical vessel or space in which the piston makes reciprocating produces.

Piston: - It is a cylindrical component fitted into the cylinder forming the moving boundary of combustion system. It fits in cylinder perfectly.

Combustion Chamber: - It is the space enclosed in the upper part ofcylinder, by the cylinder head & the piston top during combustion process.

Inlet Manifold: - The pipe which connects the intake system to the inletvalve of engine.
Exhaust Manifold: - The pipe which connects the exhaust system to theexhaust valve of engine.
Inlet / Exhaust Valves: - They are provided on the cylinder head to head toregulate the charge coming into or going out of the chamber.
Spark Plug: - It is used to initiate the combustion process in S.I engines.
Connected Rod: - It connects piston & the crank shaft.
Crank shaft: - It converts the reciprocating motion of the piston into usefulrotary motion of output shaft.
Gudgeon pins: - It forms a link between connection rod and the piston.
Cam shaft: - It controls the opening & closing of the valves.
Cam: - They open the valves at the correct tunes.
Carburetor: - Used in S.I engine for atomizing & vaporizing and mixture itwith air in varying proportion.

Experiment No. -2

Aim: - To study the constructional details & working principles involved in a 2-Stroke & 4Stroke Diesel Engines.

Apparatus: - **Model of 2-Stroke / 4-Stroke Diesel Engine.**

Theory: -

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.

Construction Details

Suction: - During suction stroke, air is inducted through inlet valve.

Compression: - The air inducted is compressed into the clearance volume.

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.

Exhaust: - The piston traveling from BQC to TDC pushes out the products of combustion out of cylinder.

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 thecycle one for compressing the fresh charge and other for expansion or power stroke.

Compression: - The air or charge is inducted into the crankcasethrough the spring loaded inlet valve when the pressure in crankcase is reduced due to upward motion of piston.

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

Cylinder: - In it the piston makes a reciprocating process motion.

Piston: - It is a cylindrical component fitted into the cylinder formingthe moving boundary of the combustion system. It fits into cylinder.

Combustion Chamber: - The space enclosed in the upper part of thecylinder, by the head and the piston top during the combustion process.

Inlet/ Outlet ports: - They are provided on the side of cylinder to regulate the charge coming in and out of cylinder.

Fuel Injector: - It injects the fuel in combustion chamber to initiatecombustion process for power stroke.

Connecting Rod: - It interconnects crank shaft and the piston.

Fly Wheel: - The net torque imparted to the crankshaft during one complete cycle of operation of the engine fluctuates cow sing change in angular velocity of shaft. In order to achiever uniform torque an internalmass is attached to the output shaft & this is called as fly wheel.

Experiment No. -3

AIM:- Analysis of exhausts gases from Two-Stroke single-cylinder petrol engine by Orsat Apparatus.

APPARATUS USED:- Orsat apparatus, caustic potash solution, alkaline solution of pyrogallic acid, cuprous chloride solution, brine and dryflue gas sample.

THEORY:-To check the combustion efficiency of I. C. engines, it is essential to know the constituents of the flue gases being exhausted. The various constituents the flue gases are CO_2, excess O_2, CO, SO_2, and N_2.The volumetric analysis of mainly CO_2, O_2, and CO is required, because the heat released is sufficiently large when carbon of the fuel burns to rather than when it burns to CO, secondly to determine the requisite amount of oxygen for proper burning of fuel. Such an analysis can be carried out conveniently with the help of Or sat apparatus.

An Orsat apparatus is shown in figure. It consists of three flasks to absorb differentgases. Flask no. 1 contains caustic potash solution and this absorbs CO_2 present in the flue gas. Similarly flask no. 2 and 3 contains alkaline solution of pyro Gallic acid, and cuprous chloride solution to absorb O_2, and CO respectively.

100 ml of a dry flue gas sample is sucked in the eudiometer tube of the apparatus and is allowed to react with the three solutions turn by turn. The amount of CO_2, O_2, and CO absorbed in the respective solution is estimated from the eudiometer scale.

PROCEDURE:-

Fill 2/3 of the aspirator bottle with the brine solution.

Fill three flasks i.e. flask no. 1, 2,and 3 with the required quantity of the caustic potash solution, alkaline solution of pyro Gallic acid, and cuprous chloride solution respectively and close their valves.

Open the valve of flask no. 1, now by operating the rubber bladder and opening the three way cock to the atmosphere, bring the level of caustic potash solution to the mark A. close the valve of flask no. 1.

Repeat as step 3, to bring the level of alkaline solution of pyro Gallic acid, and cuprous chloride solution to their respective marks B and C. Close the valves of flask no. 2 and 3.

Open the three-way cock to the atmosphere and raise the aspirator bottle so that air present in the Eudiometer is expelled to atmosphere. Close the three way cock and lower the aspirator bottle to read zero on eudiometer scale.The eudiometer is ready to receive 100 ml of gas sample.

Open the three-way cock and allow the flue gas sample to enter the eudiometer. Close the three-way cock, now 100 ml of gas has entered the apparatus. Open the three-way cock to the atmosphere and raise the aspiratorbottle so that whole gas present in the eudiometer is expelled to atmosphere. Repeat this step twice or thrice so that 100 ml of representative flue gas sample remain in the apparatus. Close the three way cock finally.

Now open the valve of flask no. 1. Raise and lower the aspirator bottle few times so that gas is passed-in and out of flask several times. Lower the aspirator bottle and bring the level of caustic potash solution again to mark

A. Close the valve of flask. Bring the aspirator bottle near the eudiometerand position it so that, the liquid level in the both is same. Note the liquid level on the scale. This gives the %age of CO_2 present in the flue gas sample.

Repeat the procedure as step 7 to determine the %age of O_2, and CO respectively by passing the remaining sample through the two flasks.

OBSERVATIONS:-

Amount of flue gas after absorption by caustic potash solution = X ml

Amount of flue gas after absorption by alkaline solution of pyro Gallic acid = Y mlAmount of flue gas after absorption by cuprous chloride solution = Z ml

CALCULATIONS:-

Amount of flue gas sample = 100 ml

Amount of CO_2 = (100 - X) ml

Amount of O_2 = (X –Y) ml

Amount of CO = (Y + Z) ml

Amount of N_2 = (100 – Z) ml

PRECAUTIONS:-

The apparatus should be air tight.

The eudiometer tube of the apparatus should be well flushed with the flue gas sample before performing the experiment.

The brine solution in the aspirator bottle should be saturated, as it mayabsorb some constituents of the gas sample and thereby cause errors.

RESULTS:- Performance curves are plotted and they are similar to the standard performance Curves.

Experiment No. -4

AIM:- To prepare heat balance sheet on Single-Cylinder Diesel Engine.

APPARATUS USED :- Single-Cylinder Diesel Engine (Constant Speed) Test Rig, Stop Watch and Digital Tachometer.

THEORY:-

The thermal energy produced by the combustion of fuel in an engine is not completely utilized for the production of the mechanical power. The thermal efficiency of I. C. Engines is about 33 %. Of the available heat energy in the fuel, about 1/3 is lost through the exhaust system, and 1/3 is absorbed and dissipated by the cooling system.
It is the purpose of heat balance sheet to know the heat energy distribution, that is, how and where the input energy from the fuel is is distributed.
The heat balance sheet of an I. C. Engine includes the following heat distributions:

Heat energy available from the fuel brunt.

Heat energy equivalent to output brake power.

Heat energy lost to engine cooling water.

Heat energy carried away by the exhaust gases.

Unaccounted heat energy loss.

FORMULE USED :-

Torque, $\mathbf{T = 9.81 \times W \times R_{Effective}}$ N-m.

; Where $R_{Effective} = (D + d)/2$

or $(D + t_{Belt})/2$m,

w=(Load) = $(S_1 - S_2)$Kg,

Brake Power, $\mathbf{BP = (2\pi N T) / 60,000}$KW

; Where N = rpm, T = Torque N-m,

Fuel Consumption, $\mathbf{m_f = (50\ ml \times 10^{-6} \times \rho_{Fuel}) / (t)}$ Kg/Sec

Here; ⟹ 1 ml = 10^{-3} liters, and 1000 liters = 1 m^3

So 1 ⟹ ml = 10^{-6} m^3

Heat energy available from the fuel brunt, $\mathbf{Q_s = m_f \times C.V. \times 3600}$KJ/hr.

Heat energy equivalent to output brake power, $\mathbf{Q_{BP} = BP \times 3600}$KJ/hr.

Heat energy lost to engine cooling water, $\mathbf{Q_{CW} = m_w \times C_w (t_{wo} - t_{wi}) \times 3600}$KJ/hr.

Heat energy carried away by the exhaust gases, $\mathbf{Q_{EG} = m_{fg} \times C_{fg} (t_{fg} - t_{air}) \times 3600}$ KJ/hr

; Where $m_{fg} = (m_f + m_{Air})$ Kg/Sec, and $m_{Air} = C_d\ A_o \sqrt{2\ g\ \Delta h\ \ \rho_{Air}\ \rho_{Water}}$ Kg/ Sec

; Where C_d (Co-efficient of Discharge) = 0.6, $\rho_{Air} = (P_a \times 10^2) / (R \times T_a)$ Kg/ m^3,
A_o (Area of Orifice) = $(\pi\ d^2)/4$ *o* *1*
P = 1.01325 Bar,
R = 0.287KJ/Kg . K,
$T_a = (t_a + 273)$K, t_a = Ambient Temperature ^{O}C

Unaccounted heat energy loss, $\mathbf{Q_{Unaccounted} = Q_s - \{ Q_{BP} + Q_{CW} + Q_{EG} \}}$ KJ/hr.

PROCEDURE :-

Before starting the engine check the fuel supply, lubrication oil, and availabilityof cooling water. Set the dynamometer to zero load and run the engine till it attain the workingtemperature and steady state condition.

Note down the fuel consumption rate, Engine cooling water flow rate, inlet and outlet temperature of the engine cooling water, Exhaust gases cooling water flow rate, Air flow rate, and Air inlet temperature.
Set the dynamometer to 20 % of the full load, till it attains the steady state condition. Note down the fuel consumption rate, Engine cooling water flowrate, inlet and outlet temperature of the engine cooling water, Exhaust gases cooling water flow rate, Air flow rate, and Air inlet temperature.
Repeat the experiment at 40 %, 60 %, and 80 % of the full load at constant speed.
Disengage the dynamometer and stop the engine.

Do the necessary calculation and prepare the heat balance sheet.

OBSERVATIONS:-		
Engine Speed, N	= 1500	rpm
No. of Cylinders, n	= Single	
Calorific Value of Fuel, C.V.	= 38,000	KJ/Kg
Specific Heat of Water, C_w	= 4.187	KJ/Kg. K
Specific Heat of Exhaust Flue Gases, C_{fg}	= 2.1	KJ/Kg. K

Gas Constant, R Ambient Temperature, t_a	= 0.287 =298	KJ/Kg. K $^o C$
Atmospheric Pressure, P_a	= 1.01325	Bar
Orifice Diameter, d_o	= 25 x 10^{-3}	m
Co-efficient of Discharge, C_d	= 0.6	
Density of fuel (Diesel), ρ_{Fuel}	= 810 to 910	Kg/m^3
Density of Water, ρ_{water} Brake Drum Diameter, D Rope Diameter, d	= 1,000 = 181.5 x 10^{-3}	Kg/m^3m m
Or Belt thickness, t_{Bel}	= 5.5 x 10^{-3}	m

OBSERVATIONS TABLE :-

Sl. No.	Engine Speed, N (rpm)	Dynamometer Spring Balance Readings, (Kg)		Time taken for 50 ml fuel, t (Sec.)	Engine Cooling Water Flow Rate, Mw (Kg/hr.)	Engine Cooling Water Temperatures, (^{o} C)		Exhaust Gas Temperature, t_f(^{o} C)	Manometer Reading, Δh (m)
		S_1 (Kg)	S_2 (Kg)			t_{wi} (^{o} C)	t_{wo} (^{o} C)		
1.	1500								
2.	1500								
3.	1500								

<u>CALCULATIONS</u>:-

RESULT TABLE :-

Sl. No.	Engine Speed, N (rpm)	Brake Power, BP (KW)	Fuel Consumption, Mf (Kg/hr.)	Air Flow Rate, m_{air} (Kg/hr.)	Exhaust Gas Flow Rate, $m_{fg.}$ (Kg/hr.)
1.	1500				
2.	1500				
3.	1500				
4.	1500				

HEAT BALANCE SHEET :-

Heat Energy Supplied	KJ/hr.	% age	Heat Energy Consumed (Distribution)	KJ/hr	% age
Heat energy available from the fuel brunt			(a) Heat energy equivalent to output brake power.		
			(b) Heat energy lost to engine cooling water.		
			(c) Heat energy carried away by the exhaust gases.		
			(d) Unaccounted heat Energy Loss.		
Total	_____	100 %	Total	____________	100 %

RESULTS:- Performance curves are plotted and they are similar to the standard performance Curves.

Experiment No. -5

AIM:-To find the indicated power (IP) on Multi-Cylinder Petrol Engine by Morse test.
APPARATUS USED: - Multi-Cylinder Petrol Engine Test Rig, Stop Watch, Hand Gloves, and Digital Tachometer.
THEORY :-

The purpose of Morse Test is to obtain the approximate Indicated Power of a Multi-cylinder Engine. It consists of running the engine against a dynamometer at a particular speed, cutting out the firing of each cylinder in turn and noting the fall in BP each time while maintaining the speed constant. When one cylinder is cut off, power developed is reduced and speed of engine falls. Accordingly the load on the dynamometer is adjusted so as to restore the engine speed. This is done to maintain FP constant, which is considered to be independent of the load and proportional to the engine speed. The observed difference in BP between all cylinders firing and with one cylinder cut off is the IP of the cut off cylinder. Summation of IP of all the cylinders would then give the total IP of the engine under test.

FORMULE USED :-

Brake Power**, BP = WN/ C** KW

Where W = Load on the Dynamometer, Kg,

N = rpm of the Engine

C = Dynamometer Constant.
Indicated Power **(IP)** of each Cylinder:

$IP_1 = (BPT - BP_{2,3,4})$ KW

$IP_2 = (BPT - BP_{1,3,4})$ KW

$IP_3 = (BPT - BP_{1,2,4})$ KW

$IP_4 = (BPT - BP_{1,2,3})$ KW

Total IP of the Engine, $IP_T = (IP1 + IP_2 + IP_3 + IP_4)$ KW
Mechanical Efficiency, $\eta_{mechanical} = BP_T / IP_T$

PROCEDURE:-
Before starting the engine check the fuel supply, lubrication oil, and availabilityof cooling water.

Set the dynamometer to zero loads.

Run the engine till it attains the working temperature and steady state condition. Adjust the dynamometer load to obtain the desired engine speed. Record this engine speed and dynamometer reading for the BP calculation.

Now cut off one cylinder. Short-circuiting its spark plug can do this.

Reduce the dynamometer load so as to restore the engine speed as at step 3. Record the dynamometer reading for BP calculation.

Connect the cut off cylinder and run the engine on all cylinders for a short time.This is necessary for the steady state conditions.

Repeat steps 4, 5, and 6 for other remaining cylinders turn by turn and recordthe dynamometer readings for each cylinder.

Bring the dynamometer load to zero, disengage the dynamometer and stop theengine.

Do the necessary calculations.

OBSERVATIONS:-

Engine Speed, N = rpm

No. of Cylinders, n = Four

Calorific Value of Fuel, C.V. = 42,000 KJ/Kg

OBSERVATIONS TABLE :-

Sl. No.	Cylinders Working	Dynamometer Reading, (KW)	Brake Power, BP (KW)	IP of the cut off cylinder, (KW)
1.	1-2-3-4	-------------------	BP_T	
2.	2-3-4		$BP_{2,3,4}$ =	IP_1 =
3.	1-3-4		$BP_{1,3,4}$ =	IP_2 =
4.	1-2-4		$BP_{1,2,4}$ =	IP_3 =
5.	1-2-3		$BP_{1,2,3}$ =	IP_4 =

CALCULATIONS:-

RESULT:- Total IP of the Multi-Cylinder Petrol Engine by Morse Test, IP_T = KW

Experiment No. -6

AIM:- To prepare variable speed performances test on a Two-Stroke, Single- Cylinder Petrol Engine and prepare the curves: (i) BP, BSFC, BMEP, Torque Vs Speed and (ii) Volumetric Efficiency & A/F Ratio Vs. Speed.

APPARATUS USED :- Two-Stroke, Single-Cylinder Petrol Engine Test Rig, Stop Watch, and Digital Tachometer.

THEORY :-

S.I. Engines are often used for automotive purposes. It is important to know the torque, brake mean effective pressure, and specific fuel consumption over the engine working speed range. For this purpose variable speed test at full load and part load is conducted. To test the park ignition engine at full load the throttle valve is kept wide open and the brake load is adjusted to obtain the lowest desired speed. The ignition timing may be set to obtain maximum output at this speed. Rate of fuel consumption, dynamometer load reading and speed are recorded.

FORMULE USED:-

Torque, $\mathbf{T = 9.81 \times W \times R_{Effective}}$ N-m.

; Where $R_{Effective} = (D + d)/2$m,

W (Load) = $(S_1 - S_2)$ Kg,

Brake Power, $\mathbf{BP = (2\pi N T) / 60,000}$ KW

; Where N = rpm,

T = Torque N-m,

Indicated Power, $\mathbf{IP = n\,(P_m \times L_{Stroke} \times A \times N') / 60,000}$ KW

Where P_m = Mean Effective Pressure N/ m^2,

L_{Stroke} = Stroke m

A (Cross Section of the Cylinder) = $(\pi D^2)/ 4 m^2$,

N (Number of Power Strokes/ min.)= N/ 2 per min.

For Four-StrokeEngine, N =per min

For Two-Stroke Engine, N =rpm,

n = Number of Cylinders.

Fuel Consumption, $m_f = (50 \text{ ml} \times 10^{-6} \times \rho_{Fuel}) / (t)$Kg/Sec.

Here; ⟹ $= 10^{-3}$ liters, and 1000 liters = 1 m^3

So ml ⟹ $= 10^{-6}$ m^3

Brake Mean Effective Pressure, BMEP = (BP x 60,000)/ (L_{Stroke} x A x N')N/ m^2

Where L_{Stroke} = Stroke m,

A (Cross Section of the Cylinder) = $(\pi D^2_{Bore})/4$ m^2,
N' (Number of Power Strokes/ min.= N/ 2 per min.;
For Four-Stroke Engine. = N per min;
For Two-Stroke Engine., and N = rpm.
Brake Specific Fuel Consumption, BSFC = $(m_f \times 3600)$ / B P Kg/ KW.hr.

Indicated Specific Fuel Consumption, ISFC = $(m_f \times 3600)$ / I P Kg/ KW .hr

Indicated Thermal Efficiency, $\eta_{\text{Indicated Thermal}}$ = (I P x 100) / $(m_f \times C.V.)$%

Brake Thermal Efficiency, $\eta_{\text{Brake Thermal}}$ = (B P x 100) / $(m_f \times C.V.)$%

Mass of the Air, $m_{Air} = C_d A_o \sqrt{2}\ g\ \Delta h\ \rho_{Air}\ \rho_{Water}$ Kg/ Sec;

Where C_d (Co-efficient of Discharge) = 0.6, $\rho_{Air} = (Pa \times 10^2) / (R \times T_a)$ Kg/ m^3

A_o (Area of Orifice) = $(\pi d_o^2)/ 4$ m^2,

P_a = 1.01325 Bar,

R = 0.287 KJ/ Kg.
K, Ta = (ta + 273 K,)
Ta = Ambient Temperature ^{O}C

Air Fuel Ratio, A/F = (m_{Air} / m_f) Kg/ Kg of Fuel
Volumetric Efficiency, $\eta_{\text{Volumetric}}$ = (VAir x 100)/ V_s%

Where V_{Air} (Volume of air inhaled/ Sec.)

(m_{Air} / ρ_{Air}) m^3/ Sec.V_s (Volume/ Sec.) = n . (L_{Stroke} . A. N)/ 60 m^3/ Sec.,
And Volume of fuel is Neglected (Based on free air conditions),

L_{Stroke} = Stroke m,

A (Cross Section of the Cylinder) = $(\pi D^2)/ 4$ m^2

N (Number of Power Strokes/ min.)= N/ 2 per min. ;
For Four-Stroke Engine . = N per min ;

For Two-Stroke Engine., N =rpm.

n = Number of Cylinders.

Mechanical Efficiency, $\eta_{mechanical}$ = BP / IP

PROCEDURE:-

Before starting the engine check the fuel supply, lubrication oil. Set the dynamometer to zero load.

Run the engine till it attains the working temperature and steady statecondition. Adjust the dynamometer load to obtain the desired engine speed. Note downthe fuel consumption rate. Adjust the dynamometer to the new value of the desired speed. Note and record the data as in step 4. Repeat the experiment for various speeds upto the rated speed of the engine.

Do the necessary calculations.

OBSERVATIONS:-		
No. of Cylinders, n	= Single	
Brake Drum Diameter, D	= 156×10^{-3}	m
Rope Diameter, d	= 18×10^{-3}	m
Bore, D_{Bore}	= 56.5×10^{-3}	m
Stroke, L_{Stroke} Engine Displacement, V_{Swept}	= 58.04×10^{-3} = 145.45×10^{-6}	m m^3
Engine Horse Power, BHP	= 7.48	BHP at 5500 rpm.
Density of fuel (Petrol), ρ_{Fuel}	= 720 to 790	Kg/ m^3
Density of Manometer fluid, ρ_{Water}	= 1,000	Kg/ m^3
Calorific value of fuel (Petrol), C.V.	= 42000	KJ/ Kg
Orifice Diameter, d_o	= 25×10^{-3}	m
Co-efficient of Discharge, C_d	= 0.6	
Ambient Temperature, t_a	=	K
Atmospheric Pressure, P_a	= 1.01325	Bar

OBSERVATION TABLE:

Sl. No.	Engine Speed, N (rpm)	Dynamometer Spring Balance Readings, (Kg)		Time taken for 50ml fuel, t (Sec.)	Manometer Reading, Δh (m)
		S_1 (Kg)	S_2 (Kg)		

CALCULATIONS:-

RESULT TABLE:-

Sl. No.	Engine Speed, N (rpm)	Torque (N-m)	Brake Power, BP (KW)	Air Consumption Rate, m_{air} (Kg/hr)	Fuel Consumption Rate, m_f (Kg/hr)	BSFC (Kg/KW . hr)	BMEP (N/m^2)	A/F Ratio	η_{mech} % age
1.									
2.									
3.									
4.									

RESULTS:- Performance curves are plotted and they are similar to the standard performance Curves.

Experiment No. -7

AIM:- To determine Frictional Power of Four-Stroke , Single Cylinder Diesel(Constant Speed) Engine by William's Line Method.

APPARATUS USED :- Four-Stroke , Single Cylinder Diesel (Constant Speed)Engine Test Rig, Stop Watch, and Digital Tachometer.

THEORY:-

A curve between the fuel consumption rate and the Brake Power is called the Willain's Line. This method is used for determining the FP of the Diesel Engine, which is assumed to be independent of the load at constant speed. In this method, fuel consumption rate is measured for various loads at constant speed. Theload on the engine is varies with the help of dynamometer and corresponding to each setting BP is calculated. Then a graph is drawn of fuel consumption rate against the BP, and is extended back to cut the BP axis. The negative BP then corresponds to the FP at a particular speed. This method is also enables to determine IP without the use of an indicator.

FORMULE USED :-

Torque, $\mathbf{T = 9.81 \times W \times R_{Effective}}$ N-m.

Where $R_{Effective} = (D + d)/2$ or $(D + t_{Belt})/2$ m, and

W (Load) = $(S_1 - S_2)$ Kg,

Brake Power, $\mathbf{BP = (2\pi N T) / 60,000}$ KW

Where N = rpm,

T = Torque N-m,

Fuel Consumption, $\mathbf{m_f = (50\ ml \times 10^{-6} \times \rho_{Fuel}) / (t)}$ Kg/Sec.

1 ml ⇨ = 10^{-3} liters and 1000 liters = 1 m^3

So, ⇨= 1 ml = 10^{-6} m^3

Brake Specific Fuel Consumption, $\mathbf{BSFC = (m_f \times 3600) / BP}$ Kg/ KW. hr.

Friction Power, **F P = From BSFC vs. BP Curve.** KW

Indicated Power, **IP = BP + FP** KW

PROCEDURE:-

Before starting the engine check the fuel supply, lubrication oil, and availabilityof cooling water. Set the dynamometer to zero load. Run the engine till it attains the working temperature and steady state condition. Adjust the dynamometer load to obtain the desired engine speed. Note down the fuel consumption rate. Change the dynamometer load so that the engine speed Change, to maintain the engine speed constant fuel consumption increases. Note down the fuel consumption rate at this load setting. Repeat steps 5 and 6 for various loads. Disengage the dynamometer and stop the engine. Do the necessary calculation.

OBSERVATIONS:-			
Engine Speed, N	= 1500		rpm
No. of Cylinders, n	= Single		
Calorific Value of Fuel, C.V.	= 38,000		KJ/Kg
Density of fuel (Diesel), ρ_{fuel}	= 810 to	910	Kg/m^3
Brake Drum Diameter, D	= 181.5×10^{-3}		m
Rope Diameter, d	=		m
Or			
Belt thickness, t_{Belt}	= 5.5×10^{-3}		m

OBSERVATIONS TABLE:

Sl. No.	Engine Speed, N (rpm)	Dynamometer Spring Balance Readings, (Kg)		Time taken for 50 ml fuel, t (Sec.)
		S_1 (Kg)	S_2 (Kg)	
1.	1500			
2.	1500			
3.	1500			
4.	1500			

CALCULATIONS:-

RESULT TABLE:-

Sl. No.	Engine Speed, N (rpm)	Brake Power, BP (KW)	Fuel Consumption, m_f (Kg/Sec)	Brake Specific Fuel Consumption, BSFC (Kg/ KW . hr)
1.	1500			
2.	1500			
3.	1500			
4.	1500			

RESULT:- Performance curves are plotted and they are similar to the standard performance Curves and FP is calculated By **Willian's line Method**.

Experiment No. -8

AIM:- To perform constant speed performance test on a Four-Stroke Single- Cylinder Diesel Engine & Draw curves of (i) BP vs Fuel Rate, Air Rate and A/F ratio and (ii) BP vs. BMEP, Mechanical Efficiency & BSFC.

APPARATUS USED: - Four-Stroke , Single-Cylinder (Constant Speed) Diesel Engine Test Rig, Stop Watch, and Digital Tachometer.

THEORY:-

Under some circumstances (i.e Electric Generator) C. I. Engines are required to run at constant speed. For this purpose the test is to be performed at constant speed and the load is varied from zero to maximum. When load on the engine increases its speed decreases. Accordingly the fuel supply is adjusted to keep the engine speed constant. Corresponding to each load setting, dynamometer readings and fuel consumption rate are measured. The BP, BSFC, BMEP, A/F,and Mechanical Efficiency are calculated from measured data and plotted against the load.

FORMULE USED:-

Torque, $\mathbf{T = 9.81 \times W \times R_{Effective}}$ N-m.

Where $R_{Effective} = (D + d)/2$ or $(D + t_{Belt})/2$ m, and W (Load) = $(S_1 - S_2)$Kg,

Brake Power, $\mathbf{BP = (2\pi N T) / 60,000}$ KW

; Where N = rpm, T = Torque N-m,

Fuel Consumption, $\mathbf{m_f = (50\ ml \times 10^{-6} \times \rho_{Fuel}) / (t)}$ Kg/Sec.

Here; ⟹ 1 ml = 10^{-3} liters, and 1000 liters = 1 m^3

So, ⟹ 1 ml = 10^{-6} m^3

Brake Mean Effective Pressure, $\mathbf{BMEP = (BP \times 60,000) / (L_{Stroke} \times A \times N')}$ N/ m^2

Where L_{Stroke} = Stroke m,

A (Cross Section of the Cylinder) = $(\pi D^2)/4$ m^2,
N' (Number of Power Strokes/ min.)= N/ 2per min.
For Four-StrokeEngine.= N per min;
For Two-Stroke Engine., andN = rpm.
Brake Specific Fuel Consumption, $\mathbf{BSFC = (m_f \times 3600) / BP}$ Kg/ KW. hr

Mass of the Air, $\mathbf{m_{Air} = C_d A_o \sqrt{2 g \Delta h \rho_{Air} \rho_{Water}}}$ Kg/ Sec

Where C_d (Co-efficient of Discharge) = 0.6, ρ_{Air} = $(Pa \times 10^2) / (R \times T_a)$ Kg/ m^3

A_o (Area of Orifice) = $(\pi\, d_o^2)/\ 4m^2$,

P_a = 1.01325 Bar

,R =0.287 KJ/Kg . K,

T_a = (ta + 273) K,

t_a = Ambient Temperature ^{O}C

Air Fuel Ratio, **A/F = (m_{Air} / m_f)** Kg/ Kg of Fuel

Mechanical Efficiency, $\eta_{mechanical}$ **= BP / IP**

PROCEDURE:-

Before starting the engine check the fuel supply, lubrication oil, andavailability of cooling water. Set the dynamometer to zero load. Run the engine till it attains the working temperature and steady state condition. Adjust the dynamometer load to obtain the desired engine speed. Note down the fuel consumption rate. Change the dynamometer load so that the engine speed Change, to maintainthe engine speed constant fuel consumption increases. Note down the fuel consumption rate, speed, air inlet temperature, at thisload setting. Repeat steps 5 and 6 for various loads. Disengage the dynamometer and stop the engine. Do the necessary calculation.

OBSERVATIONS:-		
Engine Speed, N	= 1500	rpm
No. of Cylinders, n	= Single	
Bore Diameter, D_{bore}	=	m
Stroke Length, L_{stroke}	=	m
Calorific Value of Fuel, C.V.	= 38,000	KJ/Kg
Gas Constant, R Ambient Temperature, t_a	= 0.287 =	KJ/Kg . K ^oC
Atmospheric Pressure, P_a	= 1.01325	Bar
Orifice Diameter, d_o	= 25×10^{-3}	m
Co-efficient of Discharge, C_d	= 0.6	
Specific Gravity of fuel, ρ_{fuel}	= 810 to 910	Kg/m^3
Density of Water, ρ_{water}	= 1,000	Kg/m^3
Brake Drum Diameter, D	= 181.5×10^{-3}	m
Rope Diameter, d	=	m
Or		
Belt thickness, t_{Belt}	= 5.5×10^{-3}	m

OBSERVATIONS TABLE :-

S. No.	Engine Speed, N (rpm)	Dynamometer Spring Balance Readings, (Kg)		Time taken for 50 ml fuel, t (Sec.)	Manometer Reading, Δh (m)
		S_1 Kg	S_2 Kg		
1.	1500				
2.	1500				
3.	1500				
4.	1500				

RESULT TABLE:

Sl. No.	Engine Speed, N (rpm)	Brake Power, BP (KW)	Fuel Consumption, m_f (Kg/hr)	BSFC (Kg/ KW . hr)	BMEP (N/ m^2)	A/F Ratio	Air ConsumptionRate (Kg/ hr)	ηmech % age
1.	1500							
2.	1500							
3.	1500							
4.	1500							

RESULTS:- Performance curves are plotted and they are similar to the standard performance Curves.

Experiment No. -9

AIM:- To Study and Determine the effect of A/F Ratio on the performance of the Two-Stroke, Single-Cylinder Petrol Engine.

APPARATUS USED :- Two-Stroke, Single-Cylinder Petrol Engine Test Rig,Stop Watch, and Digital Tachometer.

THEORY:-

Air fuel ratio has a major effect on the performance of the I. C. Engine. The Air fuel ratio of a S. I. Engine lies in the range of 10: 1, to 22: 1 depends upon the power requirements and the economic running of the engine. Richer mixtures are required for idle and full throttle running of the engine. Whereas for the mid-range , weaker mixtures are required. The mixture corresponding to the minimum fuel consumption is known as the Best Economy Mixture. It is nearly 15:1.Accurate measurement of air flow into the engine is difficult to achieve in practice, due not only to the nature of the air itself, but also the conditions under which the measurement has to be made. The common method of measuring the air flow rate is the tank and orifice method. During suction stroke the pressure inside the tank is less than the atmospheric pressure. The air enters the tank through the orifice plate, and by applying the Bernoulli's equation the airflow rate can be measured. The fuel consumption can be measured by noting down the fuel consumed during specified time. Thus the air fuel ratio can be set todesired value. The accuracy of the air flow measurement depends on the steady state conditions of air flow through the orifice and the damping of the pulsating effect.

USED:-

Torque, $\mathbf{T = 9.81 \times W \times R_{Effective}}$ N-m.

; Where $R_{Effective} = (D + d)/ 2m$,

W (Load) = $(S1 - S_2)$Kg,

Brake Power, $\mathbf{B\,P = (2\pi N\,T) / 60,000}$ KW

Where = rpm, T = Torque N-m,

Fuel Consumption, $\mathbf{m_f = (50\,ml \times 10^{-6} \times \rho_{Fuel}) / (t)}$ Kg/Sec.

Here; ⟹ 1 ml = 10^{-3} liters, and 1000 liters = 1 m^3

So, ⟹ 1 ml = 10^{-6} m^3

Brake Specific Fuel Consumption, $\mathbf{BSFC = (m_f \times 3600) / B\,P}$ Kg/ KW. Hr.

Mass of the Air, $\mathbf{m_{Air} = C_d\; A_o\; \sqrt{2\; g\; \Delta h\; \rho_{Air}\; \rho_{Water}}}$ Kg/ Sec

Where C_d (Co-efficient of Discharge) = 0.6,

ρ_{Air} = (P_a x 10^2) / (R x T_a)Kg/ m^3

A (Area of Orifice) = (π $d_o^{\,2}$)/ 4 m^2,

P_a = 1.01325 Bar,
R = 0.287 KJ/Kg. K,

T_a = (ta + 273)K,

t_a = Ambient Temperature ^{O}C

Air Fuel Ratio, **A/F = (m_{Air} / m_f)** Kg/ Kg of Fuel

PROCEDURE:-

Before starting the engine check the fuel supply, and lubrication oil. Set the dynamometer to zero load. Run the engine till it attains the working temperature and steady statecondition. Adjust the dynamometer load to obtain the desired engine speed. Note down the dynamometer load reading and fuel consumption rate. Repeat the experiments for various air fuel ratios and different loads, andsame speed. Disengage the dynamometer, and stop the engine. Do the necessary calculation, and plot the graphs.

OBSERVATIONS:-		
No. of Cylinders, n	= Single	
Calorific Value of Fuel, C.V.	= 42,000	KJ/Kg
Gas Constant, R Ambient Temperature, t_a	= 0.287 =	KJ/Kg. K ^{o}C
Atmospheric Pressure, P_a	= 1.01325	Bar
Orifice Diameter, d_o	= 25 x 10^{-3}	m
Co-efficient of Discharge, C_d	= 0.6	
Density of fuel (Petrol), ρ_{fuel}	= 720 to 790	Kg/m^3
Density of Water, ρ_{water}	= 1,000	Kg/m^3
Brake Drum Diameter, D	= 156 x 10^{-3}	m
Rope Diameter, d	= 18 x 10^{-3}	m
Bore, D_{Bore}	= 56.5 X 10^{-3}	m
Stroke, L_{Stroke}	= 58.04 x 10^{-3}	m

Engine Displacement, V_{Swept} = 145.45×10^{-6} m^3

Engine Horse Power, BHP = 7.48 BHP at 5500 rpm.

OBSERVATIONS TABLE :-

Sl. No.	Engine Speed, N (rpm)	Dynamometer Spring Balance Readings, (Kg)		Time taken for 50 mlfuel, t (Sec.)	Manometer Reading, Δh (m)
		S_1 Kg	S_2 Kg		
1.					
2.					
3.					
4.					

CALCULATIONS:-

RESULT TABLE:-

Sl. No.	Engine Speed, N (rpm)	Torque (N-m)	Brake Power, BP (KW)	Air Consumptio nRate m_{air} (Kg/hr.)	Fuel Consumption ,m_f (Kg/hr.)	BSFC (Kg/ KW. hr)	A/F Ratio, (Kg/ Kg of Fuel)
1.							
2.							
3.							
4.							

RESULTS:- Performance curves are plotted and they are similar to the standard performance Curves.

Experiment No. -10

AIM:- To study and draw the valve timings diagram Four-Stroke, Single-CylinderDiesel Engine.

APPARATUS USED :- Four-Stroke, Single-Cylinder Diesel Engine Test Rig, Sprit Level, Marking Pencil, and Device for measuring crank angle.

THEORY :-

In four- stroke S. I. Engine the opening and closing of the valves, and the ignitionof the air fuel mixture do not take place exactly at the dead center positions. The valve open slightly earlier and close after their respective dead center positions.

The ignition also occurs prior, to the mixture is fully compressed, and the piston reaches the top dead center position. Similarly in a C. I. Engine both the valves donot open and close exactly at dead center positions, rather operate at some degreeon either side in terms of the crank angles from the dead center positions. The injection of the fuel is also timed to occur earlier.

PROCEDURE:-

Fix a plate on the body of the Engine touching the flywheel.

Mark the positions of the both the dead centers on the flywheel with the reference to the fixed plate. TDC and BDC in case of vertical Engines, IDC and ODC in case of horizontal Engines.

Mark on the flywheel when the inlet and exhaust valves open and close asthe flywheel is rotated slowly.

Measure the valves (Tappet) Clearance. Mark the spark ignition timing in case of petrol Engine and fuel injectiontiming in case of Diesel Engine.

Measure the angles of the various events and plot the valve timing diagram.

OBSERVATIONS TABLE :-

Sl. No.	Engine Types	Tappet Clearance		Valve Timings				
		Inlet Valve (mm)	Exhaust Valve (mm)	Inlet Valve		Exhaust Valve		Injection Timing (^{O})
				Open (^{O})	Close (^{O})	Open (^{O})	Close (^{O})	
1.	Four-Stroke, Single-Cylinder (Vertical) Diesel Engine.							

CALCULATIONS:-

RESULT:-Based on final calculation valve timing diagram is drawn and compare the standard valve timing diagram.

Viva Questions

1. What are the constructional details of a two-stroke petrol engine, and how does it differ from a four-stroke petrol engine?
2. Explain the working principles of a four-stroke diesel engine, highlighting the differences from a four-stroke petrol engine.
3. How does a two-stroke diesel engine differ from a four-stroke diesel engine in terms of construction and working?
4. What is the purpose of using an Orsat apparatus to analyze exhaust gases from a diesel or petrol engine?
5. How do you perform the analysis of exhaust gases using an Orsat apparatus?
6. What parameters can be determined using the analysis of exhaust gases, and what are their significance?
7. How do you prepare a heat balance sheet for a multi-cylinder diesel or petrol engine?
8. What is the Morse Test, and how is it used to determine the indicated horsepower (IHP) of a multi-cylinder petrol or diesel engine?
9. What is the purpose of performing a variable speed performance test on a petrol or diesel engine?
10. How do you prepare the curves for brake horsepower (BHP), indicated horsepower (IHP), fuel consumption, volumetric efficiency, and indicated specific fuel consumption (ISFC) vs. speed during a variable speed performance test?
11. Explain the Willian's line method and the motoring method for determining friction horsepower (FHP) of a multi-cylinder diesel or petrol engine.
12. What are the objectives of performing a constant speed performance test on a single or multi-cylinder diesel engine, and what curves are typically plotted during this test?
13. How do you measure carbon monoxide (CO) and hydrocarbons in the exhaust of a two-stroke or four-stroke petrol engine?
14. What is the purpose of measuring the intensity of smoke from a single or multi-cylinder diesel engine?
15. What are scavenging characteristic curves, and how are they drawn for a single-cylinder petrol engine?
16. What factors can influence the scavenging characteristics of an engine?
17. How does secondary air flow impact brake horsepower (BHP), specific fuel consumption (SFC), mechanical efficiency, and emissions in a two-stroke petrol engine?
18. What are the benefits of optimizing secondary air flow in a two-stroke petrol engine?