

**BRCM College of Engineering & Technology,  
Bahal**



**I.C. ENGINES & GAS TURBINE**  
**LAB MANUAL**  
**(ME - 317 F)**

**DEPARTMENT OF MECHANICAL ENGINEERING**

## **LIST OF EXPERIMENTS:**

1. To determine the full load performance of 4 stroke single cylinder Spark Ignition engine.
2. To determine the part load performance of 4 stroke single cylinder Spark Ignition engine.
3. To determine brake mean effective pressure of 4 stroke single cylinder spark ignition engine at part load.
4. To determine the full load performance of a four stroke single cylinder diesel engine using electric dynamometer.
5. To determine the full load performance of a single cylinder alternate fuel engine using electric dynamometer.
6. Demonstration of different mechanisms in single cylinder 4 stroke spark ignition engine.
7. Demonstration of different mechanisms in Hydraulic Assisted Power Steering (Ball Circulation).
8. Demonstration of Disc and Drum Brake mechanism.
9. Demonstration of Anti Lock Braking System mechanism.
10. Demonstration of different mechanisms in Automobile Chassis fitted with CI engine.
11. Demonstration of different mechanisms in Automobile Chassis fitted with Spark Ignition engine (In Transverse Position).

### **Experiment No. 1:**

To determine the full load performance of 4 stroke single cylinder Spark Ignition engine.

### **Method:**

Note Engine Torque and Engine Speed at full load. Calculate Power Output and Specific Fuel Consumption and plot Engine Torque, Power Output and Specific Fuel Consumption against Engine Speed.

### **Equipment:**

- Auto 3 Engine Test Unit
- Stopwatch

### **Technical Data:**

$$b.p = (2 \times \pi \times N \times T)/1000 \quad (\text{kW})$$

where,

b.p: Brake Power

N: Engine Speed (rev/sec)

T: Torque (N.m)

$$s.f.c = m_f/b.p \quad (\text{kg/kW.hr})$$

where,

s.f.c: Specific Fuel Consumption

$m_f$ : Fuel Flow Rate (kg/sec)

### **Procedure:**

1. Set the load control to the minimum position (fully anticlockwise).
2. Set the choke lever on the carburetor 90° to the barrel.
3. Set Lean/Rich device fully closed (fully clockwise) Lean or Rich.
4. Open the throttle about half way.
5. Switch on the mains electrical supply.
6. Set the joystick control to START position.
7. When the engine has started, set the joystick to FULL LOAD position and adjust the engine speed to about 40 rev/sec using the throttle and load controls.
8. Allow the engine to warm up for about 2 minutes.
9. Increase the throttle to maximum position whilst adjusting the load control to keep the speed constant and hold condition for at least 5 minutes until conditions have stabilized.
10. Note readings of Engine Torque (T) and Engine Speed (N) from instrument panel.
11. Maintaining maximum throttle, adjust the speed in 5 or 6 steps up to maximum. Allow 5 minutes for stabilization at each speed before repeating the step-10 as mentioned above.

12. Check that the fuel flow burette is full of fuel.
13. Press the PUSH TO MEASURE button so that the engine uses fuel from the burette.
14. As the fuel level in the burette drops past a convenient measuring graduation, start a stop watch. When the fuel level in the burette drops past a further convenient point, stop the stopwatch and press the PUSH TO MEASURE button again to open the solenoid fuel valve.
15. The Fuel Flow Rate ( $m_f$ ) can then be calculated using the fuel used from the burette, i.e. difference of burette readings and the time taken for the fuel to be used as given by the stopwatch.
16. After completion of readings return the throttle to its minimum position, allow engine to idle for a few minutes and then stop engine.

**Table:**

Sr. No.	Engine Speed, N (rev/sec)	Engine Torque, T (N.m)	Fuel Flow Burette Reading-1	Fuel Flow Burette Reading-2	Stopwatch Reading	Fuel Flow Rate, $m_f$ (Kg/sec)	Brake power b.p (kW)	s.f.c (kg/kW.hr)
1								
2								
3								
4								
5								

**Specimen Calculations:**

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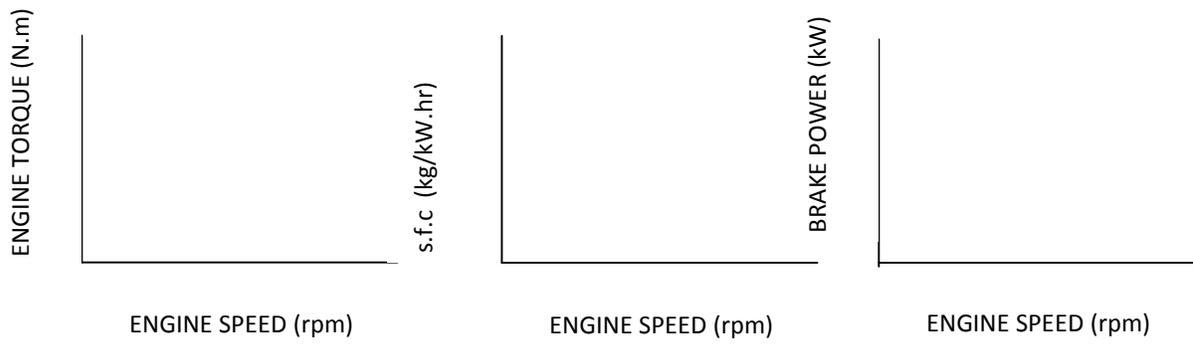
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**Graph:**

1. Engine torque against engine speed
2. Brake power against engine speed
3. Specific fuel consumption against engine speed



## **Experiment No. 2:**

To determine the part load performance of 4 stroke single cylinder Spark Ignition engine.

### **Method:**

Note Engine Torque and Engine Speed at part load. Calculate Power Output and Specific Fuel Consumption and plot Engine Torque, Power Output and Specific Fuel Consumption against Engine Speed.

### **Equipment:**

- Auto 3 Engine Test Unit
- Stopwatch

### **Technical Data:**

$$b.p = (2 \times \pi \times N \times T)/1000 \quad (\text{kW})$$

where,

b.p: Brake Power

N: Engine Speed (rev/sec)

T: Torque (N.m)

$$s.f.c = m_f/b.p \quad (\text{kg/kW.hr})$$

where,

s.f.c: Specific Fuel Consumption

$m_f$ : Fuel Flow Rate (kg/sec)

### **Procedure:**

1. Set the load control to the minimum position (fully anticlockwise).
2. Set the choke lever on the carburetor  $90^\circ$  to the barrel.
3. Set Lean/Rich device fully closed (fully clockwise) Lean or Rich.
4. Open the throttle about half way.
5. Switch on the mains electrical supply.
6. Set the joystick control to START position.
7. When the engine has started, set the joystick to HALF LOAD position and adjust the engine speed to about 40 rev/sec using the throttle and load controls.
8. Allow the engine to warm up for about 2 minutes.
9. Increase the throttle to maximum position whilst adjusting the load control to keep the speed constant and hold condition for at least 5 minutes until conditions have stabilized.
10. Note readings of Engine Torque (T) and Engine Speed (N) from instrument panel.

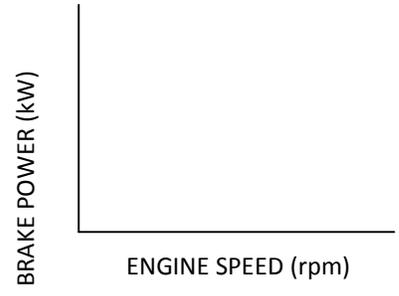
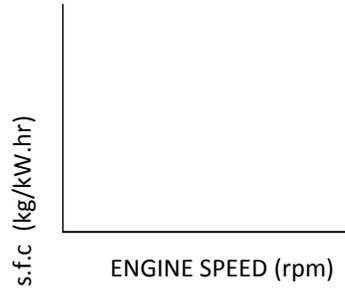
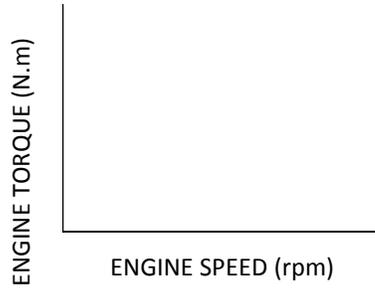
11. Maintaining maximum throttle, adjust the speed in 5 or 6 steps up to maximum. Allow 5 minutes for stabilization at each speed before repeating the step-10 as mentioned above.
12. Check that the fuel flow burette is full of fuel.
13. Press the PUSH TO MEASURE button so that the engine uses fuel from the burette.
14. As the fuel level in the burette drops past a convenient measuring graduation, start a stop watch. When the fuel level in the burette drops past a further convenient point, stop the stopwatch and press the PUSH TO MEASURE button again to open the solenoid fuel valve.
15. The Fuel Flow Rate ( $m_f$ ) can then be calculated using the fuel used from the burette, i.e. difference of burette readings and the time taken for the fuel to be used as given by the stopwatch.
16. After completion of readings return the throttle to its minimum position, allow engine to idle for a few minutes and then stop engine.

**Table:**

Sr. No.	Engine Speed, N (rev/sec)	Engine Torque, T (N.m)	Burette Reading- 1	Burette Reading- 2	Stopwatch Reading	Fuel Flow Rate, $m_f$ (Kg/sec)	Brake power b.p (kW)	s.f.c (kg/kW.hr)
1								
2								
3								
4								
5								

**Graph:**

1. Engine torque against engine speed
2. Brake power against engine speed
3. Specific fuel consumption against engine speed



### **Experiment No. 3:**

To determine brake mean effective pressure of 4 stroke single cylinder spark ignition engine at part load.

#### **Method:**

Note Engine Torque and Engine Speed at part load. Calculate Power Output and Brake Mean Effective Pressure and plot Engine Torque, Power Output and Brake Mean Effective Pressure against Engine Speed.

#### **Equipment:**

➤ Auto 3 Engine Test Unit

#### **Technical Data:**

$$b.p = (2 \times \pi \times N \times T)/1000 \quad (\text{kW})$$

where,

b.p: Brake Power

N: Engine Speed (rev/sec)

T: Torque (N.m)

$$p_{mb} = b.p/100 \times S \times A \times C \times n_c \quad (\text{bar})$$

where,

$p_{mb}$  : Brake Mean Effective Pressure

S: Stroke (m)

A: Piston Area (m<sup>2</sup>)

C: Machine Cycles Per Second

For 4 stroke engine C = N/2

For 2 stroke engine C = N

$n_c$ : Numbers of Cylinders

The engine data is:

Stroke, S = 44.4 mm

Bore Size, d = 65.1 mm

#### **Procedure:**

1. Set the load control to the minimum position (fully anticlockwise).
2. Set the choke lever on the carburetor 90° to the barrel.
3. Set Lean/Rich device fully closed (fully clockwise) Lean or Rich.
4. Open the throttle about half way.
5. Switch on the mains electrical supply.

6. Set the joystick control to START position.
7. When the engine has started, set the joystick to FULL LOAD position and adjust the engine speed to about 40 rev/sec using the throttle and load controls.
8. Allow the engine to warm up for about 2 minutes.
9. Increase the throttle to maximum position whilst adjusting the load control to keep the speed constant and hold condition for at least 5 minutes until conditions have stabilized.
10. Note readings of Engine Torque (T) and Engine Speed (N) from instrument panel.
11. Maintaining maximum throttle, adjust the speed in 5 or 6 steps up to maximum. Allow 5 minutes for stabilization at each speed before repeating the step-10 as mentioned above.
12. After completion of readings return the throttle to its minimum position, allow engine to idle for a few minutes and then stop engine.

**Table:**

Sr. No.	Engine Speed, N (rev/sec)	Engine Torque, T (N.m)	Brake power b.p (kW)	Brake Mean Effective Pressure, b.m.e.p (bar)
1				
2				
3				
4				
5				

**Specimen Calculations:**

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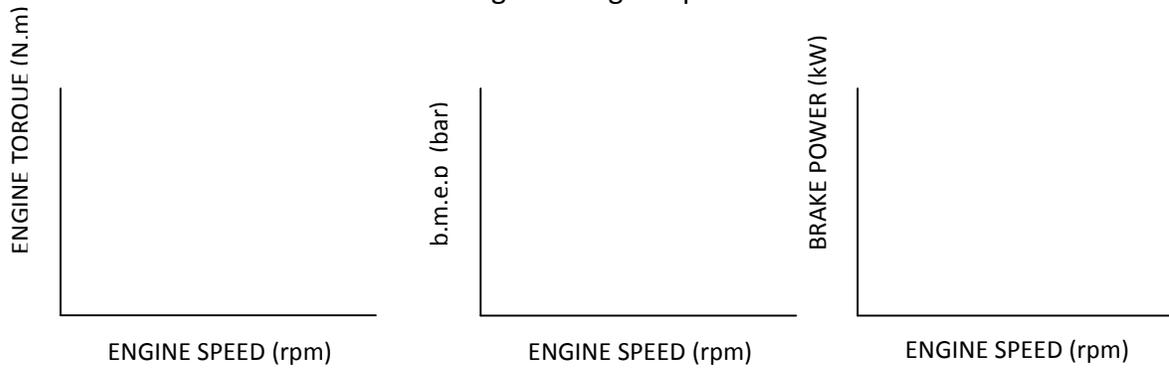
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**Graph:**

1. Engine torque against engine speed
2. Brake power against engine speed
3. Brake Mean Effective Pressure against engine speed



#### **Experiment No. 4:**

To determine the full load performance of a four stroke single cylinder diesel engine using electric dynamometer.

#### **Method:**

Note Engine Torque and Engine Speed at various positions of field load. Calculate Power Output and plot Engine Torque and Power Output against Engine Speed.

#### **Equipment:**

- Megatech Electric Dynamometer/Generator

#### **Technical Data:**

$$b.p = (2 \times \pi \times N \times T)/1000 \quad (kW)$$

where,

b.p: Brake Power

N: Engine Speed (rev/sec)

T: Torque (N.m)

#### **Procedure:**

1. Connect a 12 VDC car battery to the 12 VDC input terminals located on the back of the chassis, (+) red and (-) black.
2. Set tachometer switch to clockwise position.
3. Set the field load to 100.
4. Set the field mode to clockwise.
5. Turn power "ON" and switch the operating mode from "GEN" to "START".
6. When engine starts, switch the operating mode immediately back to "GEN" and field load rheostat to zero.
7. Start with the operating mode switch set at position no.1 and slowly increase the field load for the desired torque-rpm reading.
8. Use higher mode positions from 2 to 5 for increasingly greater load ranges.
9. Note torque and speed (rpm) from the panel of the dynamometer for every new field load position.

**Table:**

Sr. No.	Engine Speed, N (rev/sec)	Engine Torque, T (N.m)	Brake power b.p (kW)
1			
2			
3			
4			
5			

**Specimen Calculations:**

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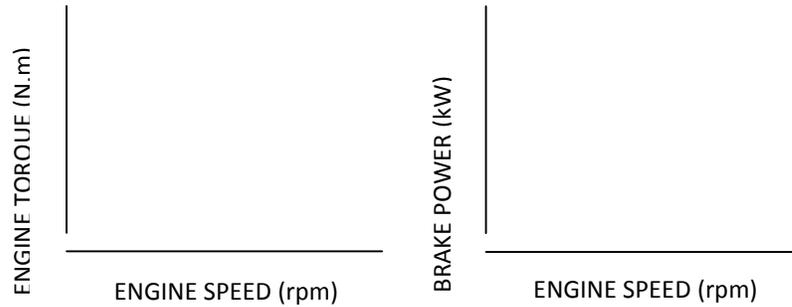
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**Graph:**

1. Engine torque against engine speed
2. Brake power against engine speed



### **Experiment No. 5:**

To determine the full load performance of a single cylinder alternate fuel engine using electric dynamometer.

### **Method:**

Note Engine Torque and Engine Speed at various positions of . Calculate Power Output and plot Engine Torque and Power Output against Engine Speed.

### **Equipment:**

- Megatech Alternate Fuel Engine attached with Electric Dynamometer/Generator

### **Technical Data:**

$$b.p = (2 \times \pi \times N \times T)/1000 \quad (\text{kW})$$

where,

b.p: Brake Power

N: Engine Speed                      (rev/sec)

T: Torque                                      (N.m)

### **Procedure:**

1. Connect a 12 VDC car battery to the 12 VDC input terminals located on the back of the chassis, (+) red and (-) black.
2. Connect the air supply to the cooling inlet at the back of the engine.
3. Using funnel pour the denatured alcohol into one of the fuel tanks.
4. Close one of the needle valves that is not in use and open the other valve two full turns.
5. Open the throttle fully.
6. Adjust the timing lever position in the back of the engine at least three quarter up position or all the way up.
7. Turn on the engine ignition switch.
8. Turn the load range switch to "HIGH".
9. Turn the load adjust knob to "100%" range position.
10. Turn field reverse switch to "+".
11. Turn the main switch from "GEN" position to the "START" position.
12. When the engine is cranking turn the load adjust knob counterclockwise to 75% range to increase the engine speed.
13. To get rid of air in the line, choke the carburetor with your finger for a second. Fuel will be flowing into the cylinder.
14. As soon as the engine starts, turn the main switch to "GEN" position and field reverse to "OFF".

15. Set the throttle to three quarter range position and adjust the needle valve until the engine runs smoothly.
- 16.
17. To load the engine set the field load reverse switch to “+”, the load adjust knob to mid range and the main switch to “LOAD”.
18. Turn the load adjust knob to five positions and check the tachometer and torque gauge readings for these five positions of load adjust knob.

**Table:**

Sr. No.	Engine Speed, N (rev/sec)	Engine Torque, T (N.m)	Brake power b.p (kW)
1			
2			
3			
4			
5			

**Specimen Calculations:**

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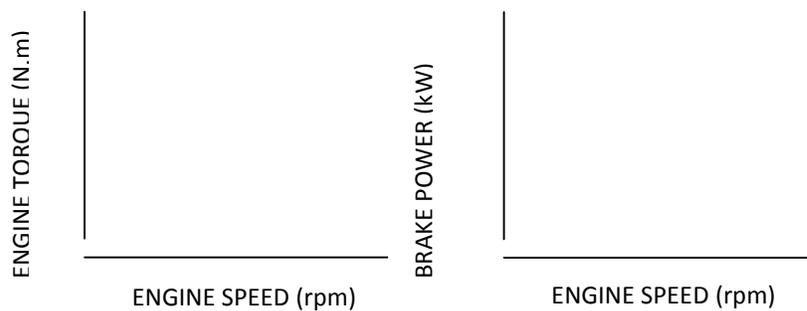
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**Graph:**

1. Engine torque against engine speed
2. Brake power against engine speed



## **Experiment No. 6:**

Demonstration of different mechanisms in single cylinder 4 stroke spark ignition engine.

### **Equipment:**

- Single Cylinder 4 Stroke SI Engine Model with EFI

### **Description of Mechanisms and Systems:**

1. Engine Components
  - i. Cylinder Block
  - ii. Cylinder Head
  - iii. Cylinder Liners
  - iv. Crank Case
  - v. Crankshaft
  - vi. Flywheel
  - vii. Connecting Rod
  - viii. Piston
  - ix. Piston Rings
  - x. Piston Pin
  - xi. Cam and Camshafts
2. Air Induction System
  - i. Air Cleaner
  - ii. Induction Manifold
  - iii. Inlet Valve
3. Exhaust System
  - i. Exhaust Valve
  - ii. Exhaust Manifold
  - iii. Silencer
4. Fuel System
  - i. Fuel Tank
  - ii. Fuel Pump
  - iii. Fuel Filter
  - iv. Fuel Regulator
  - v. Electronic Fuel Injector
5. Lubrication System
  - i. Oil Strainer
  - ii. Oil Pump
  - iii. Engine Oil Gallery
6. Cooling System
  - i. Radiator
  - ii. Water Pump

- iii. Engine Water Circulating Ports
- 7. Electric System
  - i. Electric Control Unit
  - ii. Spark Plug

**Procedure:**

Manually rotate the crankshaft pulley at the front side of engine in the direction of arrow mark. It will cause the crankshaft to move the piston inside the cylinder upward and downward. Now look at the position adopted by the inlet valve in the cylinder head, it will remain open while the piston moves from TDC to BDC. As the piston reaches BDC, observe that the inlet valve is still open to some extent and at BDC the induction stroke completes. Further rotation of crankshaft will move the piston from BDC to TDC; at a little movement of piston in TDC direction will cause the inlet valve to assume fully closed position. As the piston reaches to TDC point it compresses the previously inducted fuel mixture during induction stroke in combustion chamber. At this point when Compression stroke has been completed Engine Control unit which was monitoring the movement of the piston cause the sparking plug to spark to set the fire to compressed fuel mixture. Thus, burnt gases expand and entailed in the movement of piston from TDC to BDC which is termed as expansion stroke. In the result of expansion of burning gases piston received a severe blow while the Fly Wheel momentum and thus it compelled the crank shaft to move the piston from BDC to TDC and cam shaft to open the exhaust valve in the cylinder head to let the exhaust gases go to open atmosphere. This way a cycle of a 4 stroke 1C Engine completed to convert the heat energy into mechanical energy.

### **Experiment No. 7:**

Demonstration of different mechanisms in Hydraulic Assisted Power Steering (Ball Circulation).

### **Equipment:**

- Power Steering (Ball Circulation)

### **Description of Mechanisms and Systems:**

1. Independent Suspension Steering System
2. Axle-Beam Suspension Steering System
3. Steering Components
  - i. Steering Column
  - ii. Steering Box
    - a. Screw & Nut
    - b. Rack & Pinion
  - III. Drop Arm
  - IV. Drag Link
  - V. Track Rod
  - VI. Track Rod Arm
  - VII. Axle Beam
4. Hydraulic Assisted Power Steering Mechanism
  - i. Pump
  - ii. Control Valve
  - iii. Ram Cylinder

### **Procedure:**

As the bar twists, it rotates the inside of the spool valve relative to the outside. Since the inner part of the spool valve is also connected to the steering shaft (and therefore to the steering wheel), the amount of rotation between the inner and outer parts of the spool valve depends on how much torque the driver applies to the steering wheel. When the steering wheel is not being turned, both hydraulic lines provide the same amount of pressure to the steering gear. But if the spool valve is turned one way or the other, ports open up to provide high-pressure fluid to the appropriate line and assist the steering.

## **Experiment No. 8:**

Demonstration of Disc and Drum Brake mechanism.

### **Equipment:**

- Disc and Drum Brake

### **Description of Mechanisms and Systems:**

1. Brake Pedal Components
  - i. Master Cylinder
  - ii. Hydraulic Pipes
  - iii. Brake Drum
  - iv. Brake Discs
  - v. Brake Shoes
2. Drum Brake Mechanism
  - i. Leading and Trailing Shoe Brake
  - ii. Two Leading Shoe Brake
  - iii. Duo-Servo Brake
3. Disc Brake Mechanism
  - i. Single Cylinder Caliper
  - ii. Two Cylinder Caliper
  - iii. Four Cylinder Caliper

### **Procedure:**

As the foot pedal is operated, a piston in the master cylinder pumps fluid through the liners into the wheel cylinders. This causes the pistons in the wheel cylinders to move outwards so that the shoe or pad is brought into contact with the drum or disc. The pressure on the master cylinder piston is transmitted through the fluid in the system to apply a force to each brake. When the pedal is released a pull force is provided by an extension spring attached to the two pads.

## **Experiment No. 9:**

Demonstration of Anti Lock Braking System mechanism.

### **Equipment:**

- Anti Lock Braking System (ABS) Board

### **Description of Mechanisms and Systems:**

1. Servo Operation
  - I. Vacuum Assisted Servo
  - II. Hydraulic Assisted Servo
  - III. Compressed Air Assisted Servo
2. Anti Lock Braking System Components
  - i. Hydraulic Unit
  - ii. ECU
  - iii. Speed Electronic Sensors
  - iv. Wheel Brake Cylinders
3. ABS Mechanism
4. Need of ABS
5. Difference Between Normal, Power Assisted and ABS

### **Procedure:**

As the brake pedal depressed it closes the atmospheric valve in servo cylinder and suction valve is opened. A partial vacuum is produced on the one side of the piston while atmosphere exerts pressure on the opposite side. As pressure in the vacuum compartment get lower, atmospheric pressure forces the piston along the bore of the cylinder in the direction of vacuum port against the tension of the spring. Piston in servo compartment operate master piston in the fluid filled master cylinder that forces the fluid through the outlet valve and pipe lines to the power pistons which further force the pressurized fluid to wheel cylinders. Speed sensors are available with every wheel that send the signals about wheel skidding to the engine control unit that finally releases the pressure from the hydraulic unit and avoid the vehicle from skidding.

## **Experiment No. 10:**

Demonstration of different mechanisms in Automobile Chassis fitted with CI engine.

### **Equipment:**

- Automobile Chassis Rear-Wheel Drive with Diesel Engine

### **Description of Mechanisms and Systems:**

#### **1. Engine**

- i. Air Induction system  
Air cleaner-Induction manifold-Inlet valve
- ii. Exhaust system  
Exhaust valve- Exhaust manifold-Silencer
- iii. Fuel system  
Fuel Tank-Fuel Pump-Fuel Filter-Fuel Injection Pump-Delivery Valve-Fuel Injector
- iv. Lubrication system  
Oil strainer-Oil Pump-Engine Oil Gallery-Moving parts-Oil Pressure Gauge
- v. Cooling system  
Radiator-Water pump-Engine water circulating ports-Thermo state Valve-Water temperature Gauge
- vi. Engine Components  
Cylinder Block-Cylinder Head-Crank case-Crank shaft-Camshaft-Fly Wheel-Piston-Connecting Rod-Sleeve

#### **2. Transmission**

- i. Clutch  
Clutch Pedal-Spigot bearing-Pressure plate fingers-Clutch plate
- ii. Gear Box  
Gear box casing-Primary shaft- Secondary shaft-Main shaft
- iii. Differential Assembly  
Bevel gear- Crown Wheel-Sun Wheel-Star Pinion-Half Shafts
- iv. Wheel Axles  
Conical shaft-Wheel bearings- wheel bake plate-wheel drum.

#### **3. Brakes**

Brake pedal - Master Cylinder- Hydraulic pipes-Brake drum-Brake shoes-Brake discs

#### **4. Steering**

Steering wheel-steering rod-Rack and pinion-Drop arm-Track rod

#### **5. Electric system**

Battery-Operating Console-Starter motor-alternator-Electric fan-Heater-Indicators-Head Lights

#### **6. Road Springs**

Front suspensions-spring-shock absorber

## **Experiment No. 11:**

Demonstration of different mechanisms in Automobile Chassis fitted with Spark Ignition engine (In Transverse Position).

### **Equipment:**

- Automobile Chassis Front-Wheel Drive with Spark Ignition Engine

### **Description of Mechanisms and Systems:**

#### **1. Engine**

- i. Air Induction system  
Air cleaner-Induction manifold-Inlet valve
- ii. Exhaust system  
Exhaust valve- Exhaust manifold-Silencer
- iii. Fuel system  
Fuel Tank-Fuel Pump-Fuel Filter-Fuel Regulator-Fuel Gallery-Electronic Fuel Injector-Fuel Consumption Gauge
- iv. Lubrication system  
Oil strainer-Oil Pump-Engine Oil Gallery-Moving parts-Oil Pressure Gauge
- v. Cooling system  
Radiator-Water pump-Engine water circulating ports-Thermo state Valve-Water temperature Gauge
- vi. Engine Components  
Cylinder Block-Cylinder Head-Crank case-Crank shaft-Camshaft-Fly Wheel-Piston-Connecting Rod-Sleeve

#### **2. Transmission**

- i. Clutch  
Clutch Pedal, Spigot bearing, Pressure plate fingers, Clutch plate
- ii. Gear Box  
Gear box casing-Primary shaft- Secondary shaft-Main shaft
- iii. Differential Assembly  
Bevel gear- Crown Wheel-Sun Wheel-Star Pinion-Half Shafts
- iv. Wheel Axles  
Conical shaft-Wheel bearings- wheel bake plate-wheel drum.

#### **3. Brakes**

Brake pedal - Master Cylinder- Hydraulic pipes-Brake drum-Brake shoes-Brake discs

#### **4. Steering**

Steering wheel-steering rod-Rack and pinion-Drop arm-Track rod

#### **5. Electric system**

Battery-Operating Console-Starter motor-alternator-Electric fan-Heater-Indicators-Head Lights

#### **6. Road Springs**

Front suspensions-spring-shock absorber