I

Name_____

Roll No._____Year20__20_____

Exam Seat No._____

MECHANICAL GROUP| SEMISTER VI | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

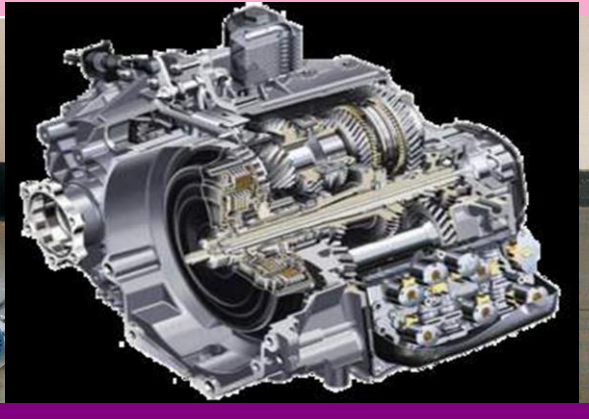
FOR

Automobile Engineering

(22656)

(ME)





MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

A Laboratory Manual for

Automobile Engineering

(22656)

Semester – VI

(Diploma in Mechanical Engineering)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO-9001-2008) (ISO/IEC 27001:2013)

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4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai -400051.
(Printed on November 2019)

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms …….
Roll No…….of Sixth Semester of Diploma in
…….of Institute
……..
(Code……..) has completed the term work satisfactorily in course Automobile Engineering **(22656)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place …… Enrollment No……
Date:…..... Exam Seat No. …….....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practical to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practical to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Automobile sector has been helping the world for the overall development and it has been creating wage and self-employment opportunities both in public and private sectors. A Mechanical engineering technologist should have an overall understanding of various aspects of Automobile Systems. This course provides a broad knowledge about the different vehicle layouts, transmissions and controls, electrical and electronics systems, vehicle safety and security, features of Motor Vehicle Acts along with automobile maintenance systems. This knowledge will be helpful to the students in co-relating various automobile systems with each other and provide good practical input with theoretical knowledge for technological advancement of the industry/society.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course

Following POs and PSO are expected to be achieved through the practical's of the (Automobile Engineering) course.

PO 1. **Basic knowledge :** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based mechanical engineering problems

PO 2. **Discipline knowledge:** Apply mechanical engineering knowledge to solve broad-basedmechanicalengineering related problems.

PO 3. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-basedmechanicalengineering problems.

PO 4. **Engineering tools:** Apply relevant mechanical technologies and tools with an understanding of the limitations

PO 5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of mechanical engineering.

PO 6. **Environment and sustainability:** Apply mechanical engineering solutions also for sustainable development practices in societal and environmental contexts.

PO 7. **Ethics:** Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of mechanical engineering

PO 8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO 9. **Communication:** Communicate effectively in oral and written form.

PO 10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the mechanical engineering and allied industry.

Program Specific Outcomes (PSOs)

PSO 1: Modern Software Usage: Use latest mechanical related software for simple design, drafting, manufacturing, maintenance and documentation of mechanical components and processes.

PSO 2: Maintenance and selection of machines, equipment, instruments: Maintain and select appropriate machine, equipment and instrument in field of Mechanical Engineering.

PSO 3: Manage Mechanical Process: Manage the mechanical process by selection and scheduling right type of machinery, equipment, substra
tes, quality control techniques, operational parameters and software for a particular mechanical process or job for economy of operations.

List of Industry Relevant Skills-

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual.

1. Use relevant tools and equipment for dismantling and assembly of various automobile system components.
2. Inspect given component/ assembly of the given vehicle.
3. Test given battery of an automobile.
4. Maintain given automobile component/ assembly.
5. Construct simple electrical circuit for automobile application

Practical- Course Outcome matrix

	Course Outcomes (COs) a. Prepare vehicle layouts with chassis specification. b. Draw the power flow diagrams of transmissions. c. Select suitable braking and steering systems for different applications. d. Select suspension system for different applications. e. Prepare simple electrical-electronic circuits for automobile systems. f. Select service tools for relevant service operation in automobile shops.						
S. No.	**Practical Outcome**	**CO a.**	**CO b.**	**CO c.**	**CO d.**	**CO e.**	**CO f.**
1.	Prepare a layout of vehicle available in your Laboratory.	√	-	-	-	-	-
2.	Dismantle, inspect and reassemble the Single Plate Clutch.(Coil Spring Type/Diaphragm Type)	-	√	-	-	-	-
3.	Dismantle, inspect and reassemble the Multi-plate Clutch.	-	√	-	-	-	-
4.	Dismantle, inspect and reassemble the Centrifugal Clutch.	-	√	-	-	-	-
5.	Dismantle, inspect and reassemble the Synchro Mesh Gear Box.	-	√	-	-	-	-
6.	Dismantle, inspect and reassemble the Propeller shaft Assembly.	-	√	-	-	-	-
7.	Dismantle, inspect and reassemble the Differential Assembly.	-	√	-	-	-	-
8.	Dismantle, inspect and reassemble the Drum/Disc Brake.	-	-	√	-	-	-
9.	Dismantle, inspect and reassemble the Steering Gear box. (Rack & Pinion/Recirculating Type/Worm and Wheel)	-	-	√	-	-	-
10.	Dismantle, inspect and reassemble the Power Steering system.(Hydraulic/ Electronic Type)	-	-	√	-	-	-
11.	Dismantle, inspect and reassemble the Leaf Spring assembly.	-	-	-	√	-	-
12.	Remove, inspect and refit the Wheel and Tyre assembly.	-	-	-	√	-	-
13.	Test a Lead Acid Battery for Open Voltage and Specific Gravity.	-	-	-	-	√	-
14.	Dismantle, inspect and reassemble the Distributor used in Battery Ignition System.	-	-	-	-	√	-
15.	Prepare a simple electrical circuit for Automobile applications like Lighting/Horn/Wiper/Flasher/Indicators/Gauges etc.	-	-	-	-	√	-
16.	Maintain given automobile component using various Service Tools.	-	-	-	-	-	√

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question banks for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practical.

Content Page

List of Practical and Progressive Assessment Sheet

S. No	Practical Outcome	Page No.	Date of performance	Date of submission	Assessment marks(25)	Dated sign. of teacher	Remarks (if any)
1.	Prepare a layout of vehicle available in your Laboratory.	1					
2.	Dismantle, inspect and reassemble the Single Plate Clutch. (Coil Spring Type/Diaphragm Type)	8					
3.	Dismantle, inspect and reassemble the Multi-plate Clutch.	17					
4.	Dismantle, inspect and reassemble the Centrifugal Clutch.	25					
5.	Dismantle, inspect and reassemble the Synchromesh Gear Box.	33					
6.	Dismantle, inspect and reassemble the Propeller shaft Assembly.	42					
7.	Dismantle, inspect and reassemble the Differential Assembly.	50					
8.	Dismantle, inspect and reassemble the Drum/Disc Brake.	59					
9.	Dismantle, inspect and reassemble the Steering Gear box. (Rack & Pinion/Recirculating Type/Worm and Wheel)	71					
10.	Dismantle, inspect and reassemble the Power Steering system. (Hydraulic/ Electronic Type)	79					
11.	Dismantle, inspect and reassemble the Leaf Spring assembly.	86					
12.	Remove, inspect and refit the Wheel and Tyre assembly.	95					
13.	Test a Lead Acid Battery for Open Voltage and Specific Gravity.	104					
14.	Dismantle, inspect and reassemble the Distributor used in Battery Ignition System.	114					
15.	Prepare a simple electrical circuit for Automobile applications like Lighting/Horn/Wiper/Flasher/Indicators/Gauges etc.	123					
16.	Maintain given automobile component using various Service Tools.	130					
Total							

Note: To be transferred to Proforma of CIAAN-2017.

Practical No. 1: Prepare a layout of vehicle available in your Laboratory.

I Practical Significance

The vehicle layout describes where on the vehicle the engine and drive wheels are found. Layouts can be divided into two categories front or rear wheel drive. Factors influencing the design choice include cost, complexity, reliability, packaging (location and size of the passenger compartment and boot), weight distribution, and the vehicle's intended handling characteristics. Hence, it is helpful to understand the vehicle layouts. In these practical the student should be able to identify and understand the types of vehicle layout.

II Relevant Program Outcomes (POs)

PO1- Basic knowledge: Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO8-Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Maintain given automobile component / assembly

IV Relevant Course Outcome(s)

- Prepare vehicle layouts with chassis specification

V Practical Outcome

- Prepare a layout of vehicle available in your Laboratory.

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Practice good housekeeping.

VII Minimum Theoretical Background

Vehicle layout is a systematic arrangement of different units which consists of engine, followed by clutch, gearbox, propeller shaft, universal joints, differential and axles that are fitted on the frame. The layout of a vehicle shows the location or position of the main parts used in vehicle performing different required functions .Vehicle layouts are classified on the basis of engine position and driving wheels in four wheeler vehicle as follows-

1. Front Engine Rear Wheel Drive (FERWD).
2. Front Engine Front Wheel Drive (FEFWD).

3. Rear Engine Rear Wheel Drive (RERWD).
4. All-wheel drive or Four Wheel Drive.

Thus, the layout of a vehicle consists of engine, followed by clutch, gearbox, propeller shaft, universal joints, differential and axles

1. **Engine:**

The Engine provides the motive power for all the various functions which the vehicle or any part of it may be called upon to perform**.**

2. **Clutch**:

Clutch is a device used in the transmission system of vehicle to engage and disengage the engine to the transmission

3. **Gear box:**

The gear box is a device which is located between the clutch and the propeller shaft. It is used to transmit the power from clutch shaft to propeller shaft.

4. **Universal Joint:**

A universal joint is used where two shafts are connected at angle to transmit torque.

5. **Propeller Shaft:**

The propeller shaft transmits power from the gearbox to the rear axle, accommodates change in length, and transmits motion at varying angles. It is connected between the gear box side universal joint and differential unit side universal joint.

6. **Differential:**

The function of the differential is to allow each rear wheel to rotate at different speeds during turning but at the sometime transmit equal torque to each wheel when both wheels have equal traction.

7. **Rear axle:**

The power from differential is transmitted to rear wheel by rear axle

8. **Front axle:**

The front axle is used to carry the weight of the front part of the vehicle as well as to facilitate steering and absorb shocks due to road surface variation

VIII Practical Diagram / Experimental setup

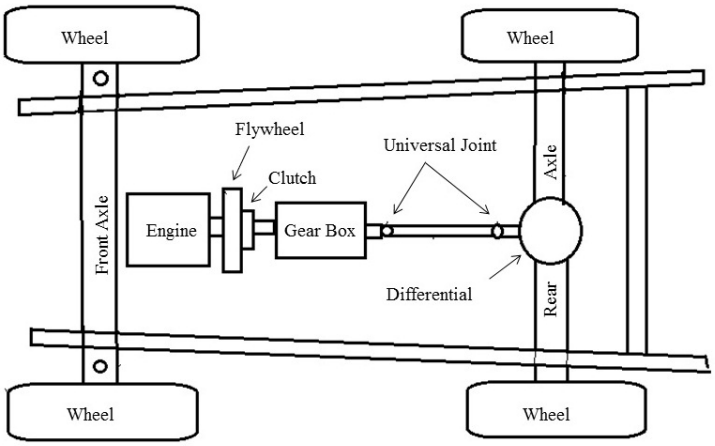

Figure1.1: General Vehicle Layout and Components

IX Resources Required

S. No.	Vehicles	Specification	Quantity	Remarks
1.	Four wheeler – LMV (Front Engine Front Wheel Drive)	Four wheeler car of make Maruti/TATA/Mahindra/Hyundai/Honda/Ford .	1	
2.	Four wheeler – LMV(Front Engine Rear Wheel Drive)	A Light motor vehicle of make Mahindra/TATA/ Force Motors/Ashok Leyland.	1	
3.	Four wheeler – LMV(Four Wheel Drive)	Mahindra Jeep/ MarutiGypsi or alike	1	

X Precautions to be Followed

1. Park the vehicle on leveled ground.
2. Apply handbrakes and ensure that wheels are properly blocked.
3. Refer the service manual of the given vehicle to know the specifications.

XI Procedure

1. Observe the layout of given vehicles.
2. Identify the location of components of transmission system.
3. Use Service manual/Operators manual or search websites and record broad specifications of major assemblies.
4. Sketch the given vehicle layouts.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations :

a) Sketch the layout of the observed Vehicle.

b) Write the details of layout used of the following Vehicles:

Sr. No.	Name of Vehicle	Type of layout used
1	Ambassador	
2	Honda City	
3	Tata Nano	
4	Mahindra Scorpio	
5	Hyundai Verna	
6	Tata Safari	
7	Maruti Suzuki	
8	Toyota Innova	

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What are the types of vehicle layout?
2. State two advantages and disadvantages of FEFWD vehicle
3. Name any two vehicles which use layout of 4WD vehicle.
4. Sketch the chassis layout of FERWD vehicle.
5. Sketch the chassis layout of FEFWD vehicle.
6. Sketch the chassis layout of RERWD vehicle.
7. Sketch the chassis layout of 4WD vehicle.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=SoR63UJ3zco
2. https://www.youtube.com/watch?v=9VQNLj5ZDZM
3. https://www.youtube.com/watch?v=ChsK7sXMsZk
4. https://www.youtube.com/watch?v=HaTO67c7haQ

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Preparation of Practical set up, Safety measures and standard practices	20%
2	Handling of service tools carefully while performing the practicals	20%
3	Identify the Probable Causes of the Troubles, Inspection, Record Keeping, Reassembly	20%
Product Related (10 Marks)		**(40%)**
4	Interpretation of result , Conclusion	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..…….
2. ……..
3. ……..
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 2: Dismantle, inspect and reassemble the Single Plate Clutch. (Coil Spring Type/Diaphragm Type)

I Practical Significance

The clutch is an important part in the transmission system of automobiles. It transmits power from the engine to the gear box at various speeds. No shock is caused during the transmission of power. In this practical we use single plate dry coil spring type or diaphragm type clutch assembly to disassemble, inspect and assemble.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - **Discipline knowledge:** Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices touse the results to solve broad-based Mechanical Engineering problems.

PO8 -**Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual.

1. Use relevant tools and equipment for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Select service tools for relevant service operation in automobile shops

V Practical Outcome

- Dismantle, inspect and reassemble the Single Plate Clutch

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

In vehicles with a manual transmission or manual transaxle the power flows through a clutch. This device engages and disengages the manual transmission or transaxle and the engine. When the driver pushes the clutch pedal down, the clutch disconnects or disengages from the engine flywheel. No engine power can flow to the transmission or transaxle. When the driver releases the clutch pedal the clutch engages. This allows power to flow to the transmission. The clutch fulfills a number of different tasks.

The three main ones are:

1. It connects/disconnects the drive between the engine and the gearbox.

2. It enables the drive to be taken up gradually and smoothly.
3. It provides the vehicle with a temporary neutral.

- **Construction and Working of Single plate Clutch :**
- **Construction:**

Driving Members: The flywheel and pressure plate are the driving members. They attach to and rotate with the engine crankshaft. The pressure plate, with one or more springs, attaches to the clutch cover. This pressure –plate assembly bolts to the flywheel and rotates with it. Spring force holds the friction disc against the flywheel while the clutch is engaged.

Driven Member: The driven member consists of a disc or plate called clutch plate. It is about 12 inches and splined to the clutch shaft. Both must turn together but the friction disc can slide back and forth on the shaft splines.

Operating Members: The operating members consists of a foot pedal, linkage, release or throw out bearings . The release bearing, which provides the bearing surface which, when the driver operates the clutch pedal, disconnects the drive between the engine and the gearbox

- **Working:**
  When the clutch pedal is depressed the pressure plate is moved to the right against the force of the springs. With this movement of pressure plate, the friction plate is released from the flywheel and the clutch is disengaged. The flywheel continues to rotate as long as the engine is running, while the clutch shaft reduces slowly and finally it stops rotating. Thus torque is not transmitted to the gear box. Now, when pedal is released, the pressure plate moves forward because of spring force and keeps the pressure on the clutch plate. At this moment the clutch plate is gripped in between flywheel and pressure plate and clutch is said to be engaged. Hence torque is transmitted to the gear box.

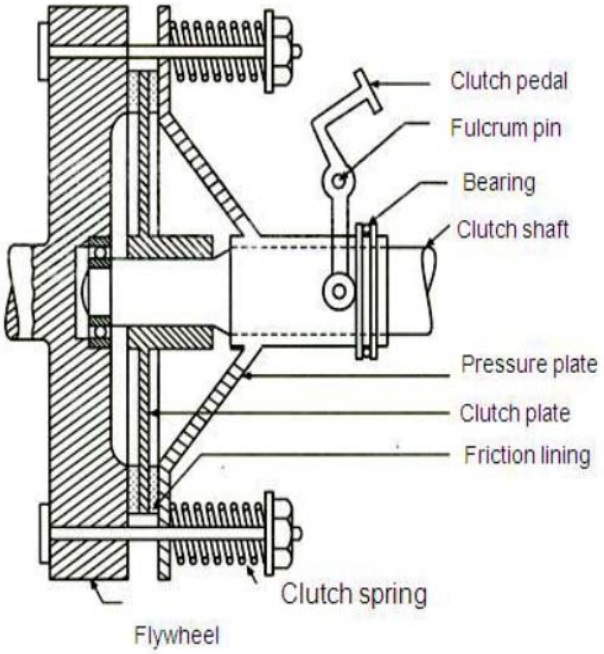

Figure 2.1: Single plate Clutch

VIII Diagram / Experimental setup

Figure 2.2: Working Model of Single Plate Clutch

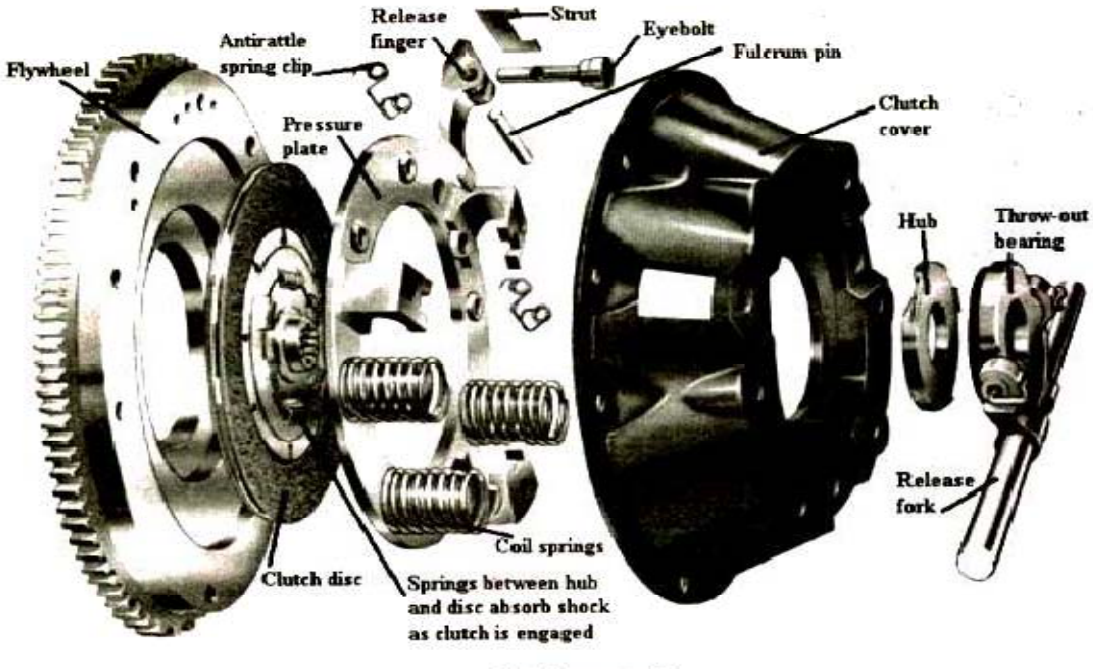

Figure2.3: Exploded view of single plate Clutch assembly

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity
1.	Demonstration working model of Single plate clutch.	Single plate coil spring type / diaphragm type clutch used in car/ light motor vehicle/heavy motor vehicle	1
2.	Basic hand tools	Open end spanner set, Ring spanner set, Socket spanner set, Ball pin Hammer, Plier, Screw driver.	1
3.	Measuring tools & Gauges	Vernier Caliper, Micrometer screw gauge, Feeler gauge.	1

X Precautions to be Followed

- Refer the appropriate service manual
- Use Specified tools, special tools and other equipments.

XI Procedure :

- **Dismantling**

1. Remove the clutch assembly from demonstration model.
2. Place the clutch assembly on the arbor press with the wooden block across the cover apply pressure with the press or clutch spring compressor to compress the springs.
3. Loosen the lock nuts while holding the eye bolt with screw driver.
4. Remove all the lock nuts and eye bolts to take out the parts.

- **Inspection:**

1. Inspect clutch disc for wear or damage: Using a vernier caliper , measure the depth between the lining surface and the rivet head .
2. Measure the pressure plate flatness across the centre using a straight edge and a feeler gauge.
3. Turn the collar while applying force in the axial direction and inspect bearing for sticking , excessive resistance, and an abnormal noise.
4. Inspect the cushioning and torsion springs on the clutch plate. In case they are found to be cracked or weak, complete plate has to be replaced

- **Assembling:**

1. Keep the pressure plate inverted and place the pressure/thrust springs on it in a vertical position seating them on their locating bosses.
2. Assemble the release levers, eyebolt and pin; lay the cover over the parts keeping the springs in position.
3. Place the wooden block across the cover and apply pressure with the press or clutch spring compressor to compress the springs, at the same time guiding the eyebolts and pressure plate lugs through the correct holes in the cover.

4. Make sure that the thrust springs are seated properly.
5. Tighten the lock nuts while holding the eye bolt with screw driver.
6. Mount the clutch plate and pressure plate assembly on the stand.
7. Check the operation of clutch for engagement and disengagement.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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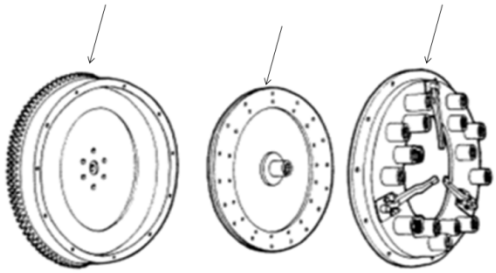
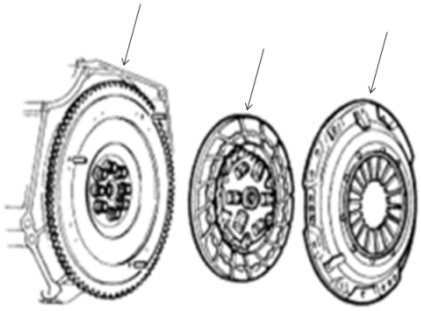
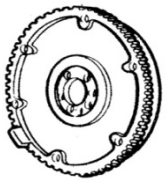
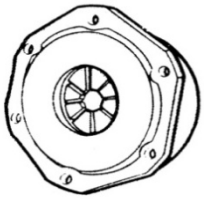
XV Observations :

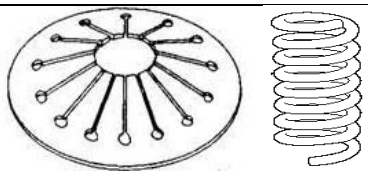
1. In a typical drive system the clutch is best located ……..
   a) Before the engine b) On the road wheels
   c) Between the Engine and gearbox d) Between the differential and wheels

2. Identify the type of clutch assemblies and label the main parts as shown in figures below :

 Type :	 Type :

Components of Clutch

Sr. No	Components	Write Function of the Components
1	 Flywheel	
2	 Pressure plate	
3	 Clutch Plate	

4	 Diaphragm / Coil Spring	
5	 Release Fork	
6	 Throw-out bearing	

XVI Results

1. Wear of clutch friction lining = …….
2. Wear of pressure disc = …….

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1. What is the need of a clutch in an automobile.
2. Describe Working principle of Clutch.
3. Write the function of torsional spring.
4. List the different friction lining material.
5. What happens if the clutch free pedal is excessive

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=kTSBwYvm7u8
2. https://www.youtube.com/watch?v=cPVYfYgD6ZM
3. https://www.youtube.com/watch?v=DsVVWRhPD34
4. https://www.youtube.com/watch?v=O-fhUs9GLYs

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 3 : Dismantle, inspect and reassemble the Multi-plate Clutch

I Practical Significance

Multi-plate wet clutch is used in power transmission system of motorcycle to transmit the engine power smoothly to drive train with reduced noise and vibrations. In this practical we use multi-plate wet clutch assembly to disassemble, inspect and assemble.

II Relevant Program Outcomes (POs)

PO1 - Basic knowledge: Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

PO8 -Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Select service tools for relevant service operation in automobile shops

V Practical Outcome

- Dismantle, inspect and reassemble the Multi-plate Clutch

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

The multi-plate clutch is an extension of single plate type where the number of frictional and metal plates is increased. The increase in the number of friction surfaces obviously increases capacity of the clutch to transmit torque ,the size remaining fixed. Alternatively the overall diameter of the clutch is reduced for the same torque transmission as a single plate clutch. By increasing the number of plates and reducing the size this clutch is used in the scooters and motorcycles where space available is limited.

Construction and Working of Multi-plate Clutch:

- **Construction:**

Multi-plate clutch consists of a number of clutch plates. The plates are alternatively fitted to the engine shaft and gear box shaft. One set of plates slides in grooves on the flywheel and the other set slides on splines of pressure plate hub. They are firmly pressed by strong coil springs and assembled in a drum. Each alternate plate has inner and outer splines.

- **Working:**

When the clutch pedal is pressed clutch springs are compressed and the friction plate move away from the clutch disc. Due to this the contact between the metal plates and friction plates is disconnected and the clutch is disengaged.

When the clutch pedal is released the clutch springs expand and forces the pressure plates on the friction plate. Due to the contact between the metal plates and friction plates the torque is transmitted and the clutch is engaged

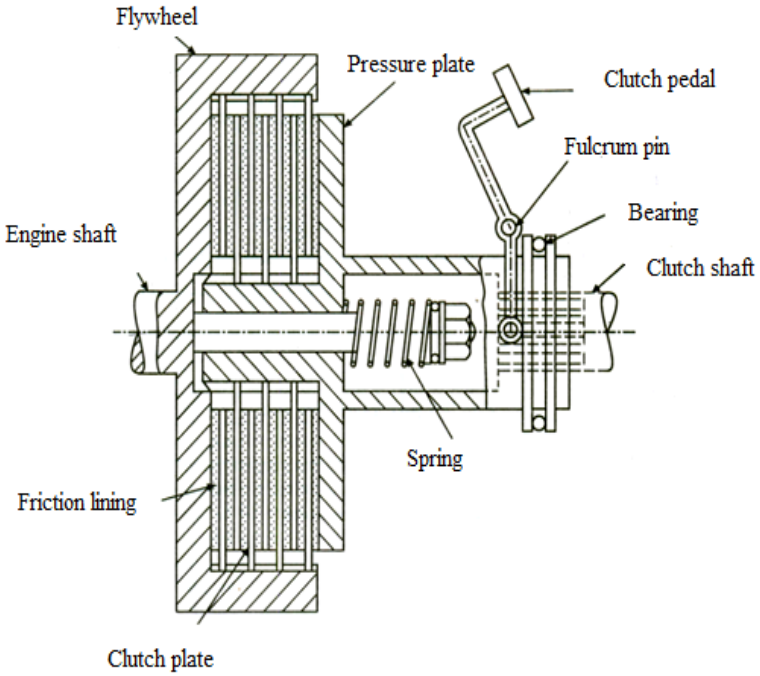

Figure 3.1: Multi-plate clutch

VIII Diagram / Experimental setup

Figure 3.2 :Multi-Plate wet Clutch assembly

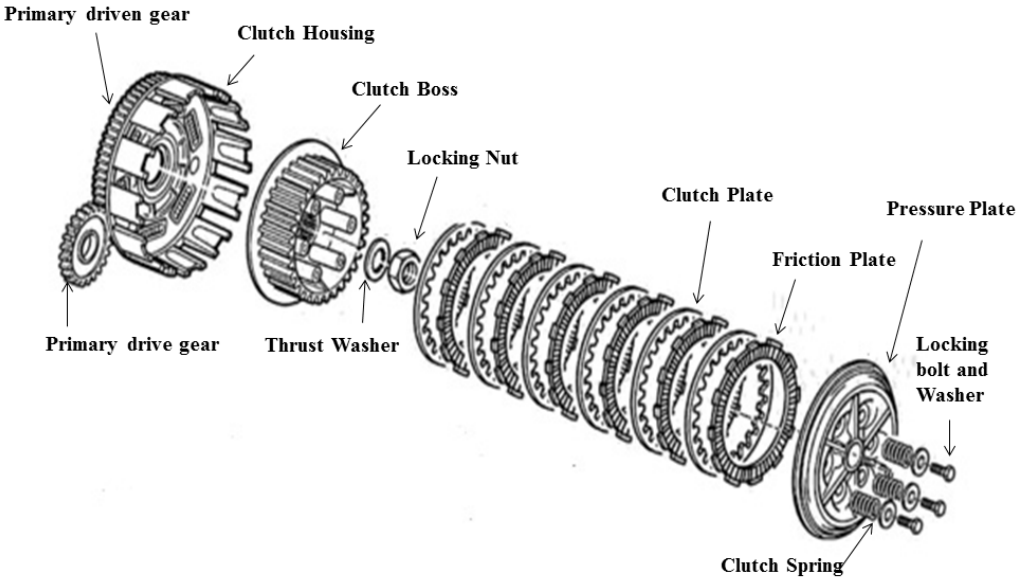

Figure3.3: Exploded view of of Multi-Plate Clutch assembly

IX Resources Required

Sr. No.	Instrument /Components	Specification	Quantity
1.	Demonstration working model/ Clutch unit	Multiplate clutch Assembly of motorcycles.	1
2.	Basic hand tools	Open end spanner set, Ring spanner set, Socket spanner set, Ball pin Hammer, Plier, Screw driver.	1
3.	Measuring tools & Gauges	Vernier Caliper, Micrometer screw gauge, Feeler gauge.	1
4.	Clutch spring compressor	**Clutch spring compressor: SST-** Includes a crossbar for removing rear case clutch springs.	1

X Precautions to be Followed

- Refer the appropriate service manual
- Use Specified tools, special tools and other equipments.

XI Procedure

Dismantling :

1. Park the motorcycles on ground level.
2. Loosen the drain plug and drain out the lubricant.
3. Disconnect clutch cable and remove the clutch cover.
4. Remove the throw out bearing.
5. Loosen the clutch spring bolts using clutch puller and spanner.
6. Take out springs, inner drum, metallic plates, friction plates etc.

7. Take out the clutch drum.

- **Inspection :**

1. Inspect friction discs , clutch plates for excessive wear and overheating.
2. Measure friction disc lining thickness with micrometer or caliper.
3. Measure free length of pressure spring with vernier caliper.

- **Assembling:**

1. Place the clutch drum on clutch shaft. Assemble the friction plates, metallic plates and springs on the inner drum using clutch puller and spanner.
2. Insert this assembly on the clutch shaft.
3. Connect the throw out bearing and clutch cover. Connect the clutch cable.
4. Fill gear oil in the gear box up to the required level.
5. Check the functioning of the clutch.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations :

SN	Part Identified	Function	Measurements (If Any)	Remark
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5				
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8				
9				
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XVI Results

1. **Wear of Friction plate = ----------**
2. **Clutch plate warpage = ----------**
3. **Free length of pressure spring = ----------**

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1. How multi-plate clutch is differ from single plate clutch.
2. Compare dry & wet multi-plate clutches.
3. Why the multi-plate clutch is used in motorcycles.
4. Explain two adjustments for the clutch.
5. Write the tightening torque applied to nuts of pressure plate cover.
6. A clutch is usually design to transmit maximum torque which is :
   a) equal to the maximum engine torque
   b) 80 per cent of maximum engine torque
   c) 150 per cent of the maximum engine torque

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=TcYsV063lk8
2. https://www.youtube.com/watch?v=7L1cnYEOpDI

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
	Total (25 Marks)	100 %

Names of Student Team Members

1. ……..
2. ……...
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 4 : Dismantle, inspect and reassemble the Centrifugal Clutch

I Practical Significance

A centrifugal clutch is a device which automatically engages and disengages as per the variation in speed . As the use of clutch pedal is eliminated , it is widely used in vehicle which have automatic transmission . To addressed the faults related to the operation of centrifugal clutch, it is essential to identify the different components of the clutch. These task includes dismantling the centrifugal clutch , identifying the components and understanding the operation .

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

PO8 -**Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual.

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Select service tools for relevant service operation in automobile shops

V Practical Outcome

- Dismantle, inspect and reassemble the Centrifugal Clutch

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

In this type of clutch, the springs are eliminated altogether and only centrifugal force is used to apply the required pressure for keeping the clutch in engagement position. The advantage of the centrifugal clutch is that no separate clutch pedal is required. The clutch is operated automatically depending upon the engine speed. Similarly while

starting, the driver can first select the gear, put the car into the gear and simply press the accelerator pedal. This makes driving very comfortable and easy.

- **Construction and Working of Centrifugal Clutch:**
  Centrifugal clutch works on the principle of centrifugal force. When the engine is started, the speed of the driving shaft is less, so the centrifugal force is also less. Therefore, shoes (flyweights) do not move outwards and torque is not transmitted to the rear wheel. As the speed of engine increases, the centrifugal force also increases. At certain engine speed, the shoes fly off outwards due to increased centrifugal force and they come in contact with the driven member. Now both the driving and driven members rotate together and the clutch is said to be engaged. Thus the engine torque is transmitted to the rear wheel. When the engine speed decreases, the centrifugal force also decreases. Now the shoes return back to their original position due to spring force which results in a disengagement of the clutch and torque is not transmitted to rear wheel

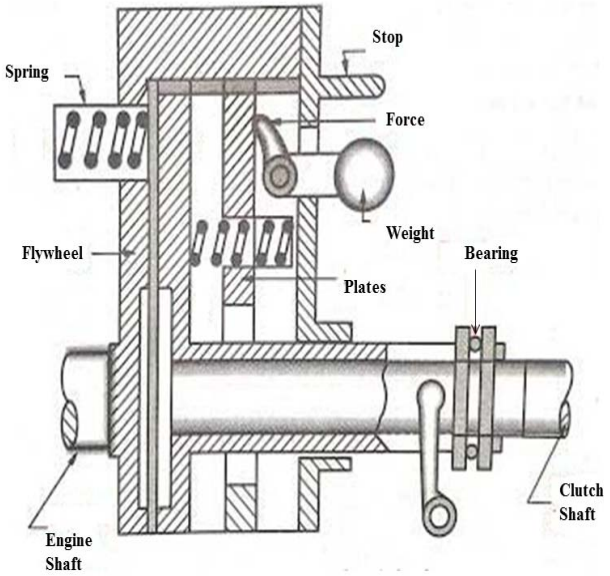

Figure 4.1: Centrifugal Clutch

VIII Practical diagram / Experimental setup :

Figure 4.2: Centrifugal Clutch Assembly

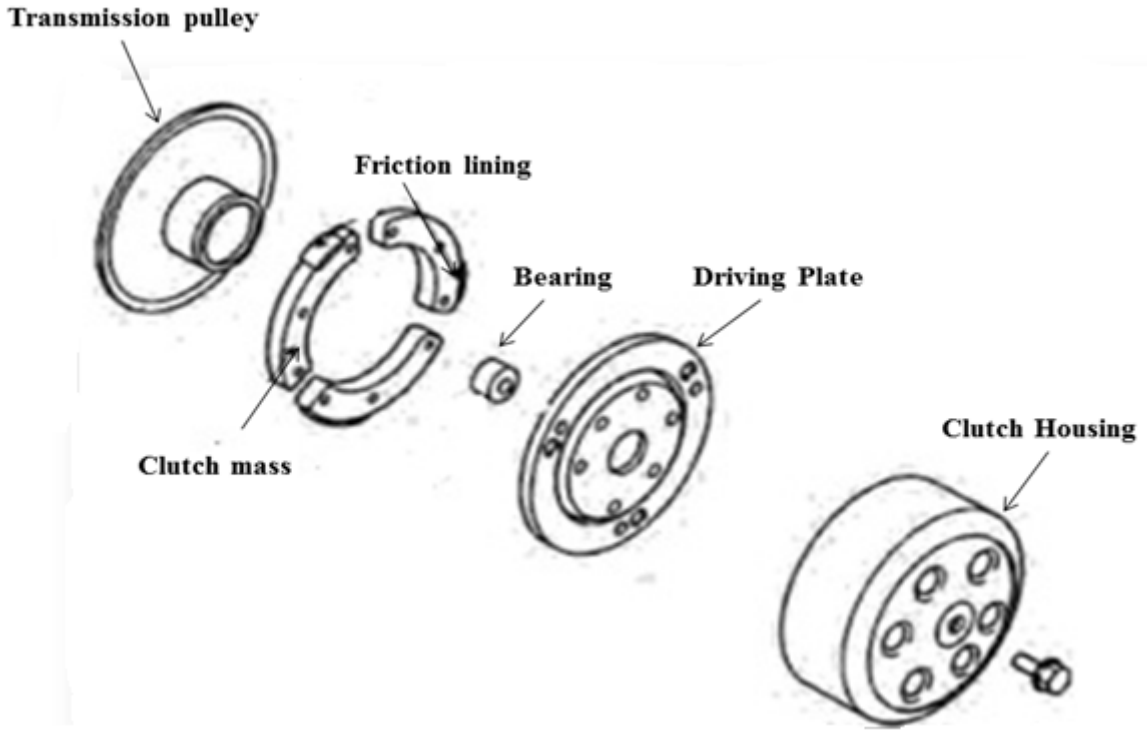

Figure 4.3: Centrifugal Clutch Assembly

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity
1.	Demonstration working model/ centrifugal cluth unit	Centrifugal clutch Assembly	1
2.	Basic hand tools	Open end spanner set, Ring spanner set, Socket spanner set, Ball pin Hammer, Plier, Screw driver.	1
3.	Measuring tools & Gauges	Vernier Caliper, Micrometer screw gauge, Feeler gauge.	1

X Precautions to be Followed

- Refer the appropriate service manual
- Use Specified tools, special tools and other equipments.

XI Procedure

- **Dismantling:**

1. Remove kickstarter pedal, if necessary
2. Remove right side crankcase cover screws using impact screwdriver
3. Remove crankcase side cover'
4. Remove gear change release mechanism
5. Remove nut from end of crankshaft
6. Slide clutch unit off of crankshaft end
7. Compress clutch release springs by pushing an Clutch plates and discs using press or vise

8. Remove large plate snap ring using: snap ring pliers.
9. Remove plates and discs
10. Remove the primary drive gear and clutch
11. Remove Centrifugal weights.
12. Compress clutch drive plate and clutch cover together to release spring tension on the cover plate attaching bolts using press or vise.
13. Remove bolts and separate drive plate and cover

- **Inspection:**

1. Clean and visually inspect all parts for obvious wear or damage
2. Measure the thickness of the disc lining using the micrometer and compare with specified value.
3. Measure the free length of all clutch springs using and compare with specified value.

- **Assembling:**

1. Install damper springs and assemble drive plate, and clutch cover and compress in press or vise
2. Install clutch 'cover bolts and tighten- to specifications
3. Install- centrifugal weights..
4. Slide primary drive gear and clutch, hub into clutch unit.
5. Install clutch plates and friction discs
6. Compress clutch release springs with a press or vise and install clutch plate retaining ring
7. Slide cutch unit onto crank-shaft
8. Install lock washer and nut on crankshaft and tighten it
9. Install gear change release mechanism
10. Install crankcase side cover and tighten screws with impact screwdriver
11. Install kickstart pedal if necessary

XII Resources Used

Make a list of different general tools , special tools and other equipments :

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations :

SN	Part Identified	Function	Measurements (If Any)	Remark
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XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What are centrifugal devices.
2. What is a function of thrust bearing
3. What are the advantages of centrifugal clutch
4. What is the material for clutch facing

[Space for Answer]

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XX References / Suggestions for Further Reading :

1. https://www.youtube.com/watch?v=zd69cDTZDco
2. https://www.youtube.com/watch?v=v6opn_jZMAE

XXI Assessment Scheme :

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. …….
2. …….
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 5 : Dismantle, inspect and reassemble the Synchromesh Gear Box.

I Practical Significance

Gear box is an important part in automobiles. It transmits power from the engine crankshaft to the rear wheels. Now a day, in most of the automobiles synchromesh gear box is used for power transmission purpose. To understand the probable faults that may occur in the gear box it is essential to identify the various components of the synchromesh gear box. This task includes the assembly , disassembly and inspection of different elements of synchromesh gear box.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices touse the results to solve broad-based Mechanical Engineering problems.

PO8 -**Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Select service tools for relevant service operation in automobile shops

V Practical Outcome

- Dismantle, inspect and reassemble the Synchro Mesh Gear Box.

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

In the Synchromesh gearbox, provision of synchromesh device avoids the necessity of double declutching. These synchromesh devices work on the principle that the two

gears to be engaged are first brought into frictional contact, to equalizes their speed , and then they are Positively engaged . By using this even unskilled drivers can engage the gears without clash or damage to the gears.

Synchromesh gearbox is similar to constant mesh gearbox except a synchronizing mechanism is additionally provided for smooth engagement of the gears.

- **Synchromesh Device :**

The engine shaft carries a pinion which meshes with a wheel fixed to the layshaft, while the gear on the main shaft is free to rotate and is permanently meshed with another wheel fixed to the layshaft. Both the pinion and the wheel on the main shaft have integral dog tooth portions and conical portions. The synchronizing drum is free to slide on splines on the main shaft.This drum has conical portions to correspond with the conical portions on the gearbox shaft pinion and on the wheel that rotates freely on the main shaft.The synchronizing drum carries a sliding sleeve. In the neutral position, the sliding sleeve is held in place by the spring loaded balls which rest in the dents in the sliding sleeve (or ring gear).

In changing gear, the gear lever is brought to the neutral position in the ordinary way, but is immediately pressed in the direction it has to go to engage the required gear.When a shift starts, the spring loaded balls cause the synchronizing drum and sliding sleeve, as an assembly to move toward the selected gear.The first contact is between the synchronizing cones on the selected gear and the drum. This contact brings the two into synchronization. Both rotate at the same speed. When the speeds of the two have become equal, a slightly greater pressure on the gear lever overcomes the resistance of the balls. Further movement of the shift fork forces the sliding sleeve on toward the selected gear. The internal splines on the sliding sleeve i.e. the dog portion, match the external splines on the selected gear the dog teeth are locked up, or engaged, and thus positive connection is established. The gear shift is completed.

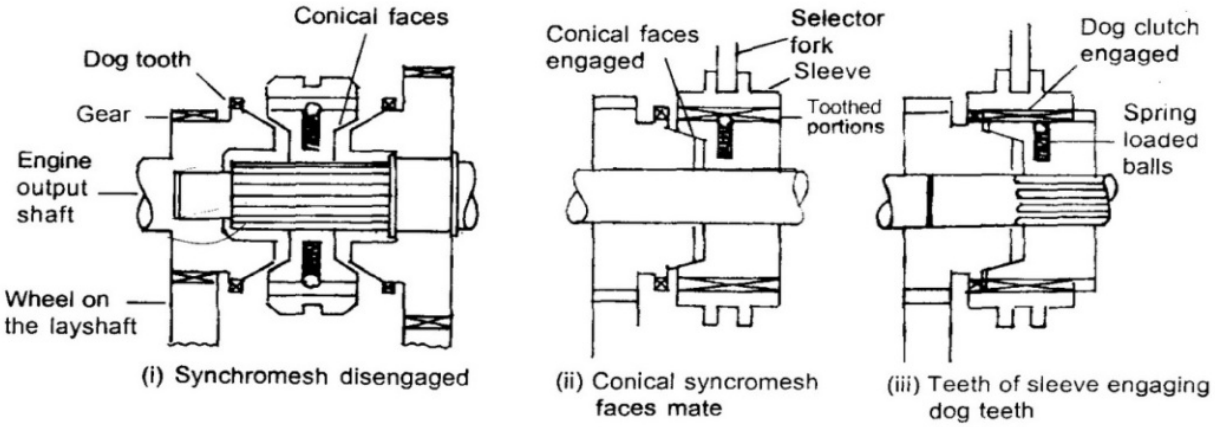

Figure 5.1: Synchromesh Device operation

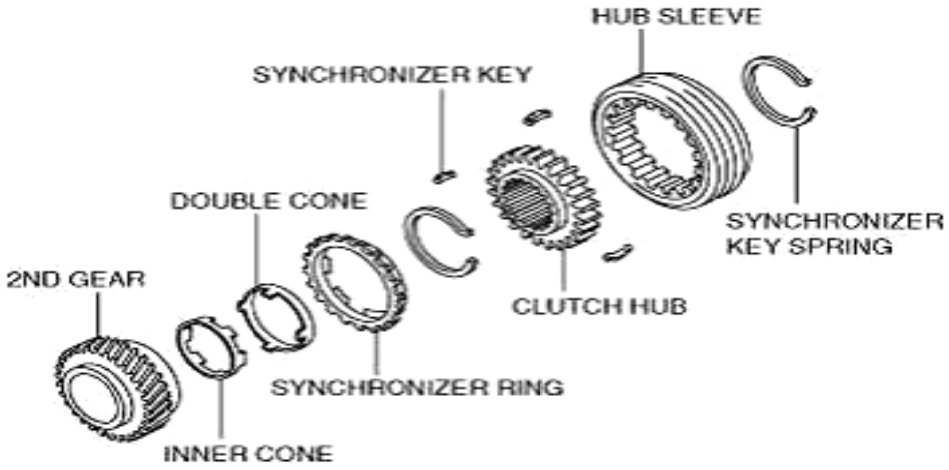

Figure 5.2: Components of Synchronizer

VIII Experimental setup / Practical Diagram :

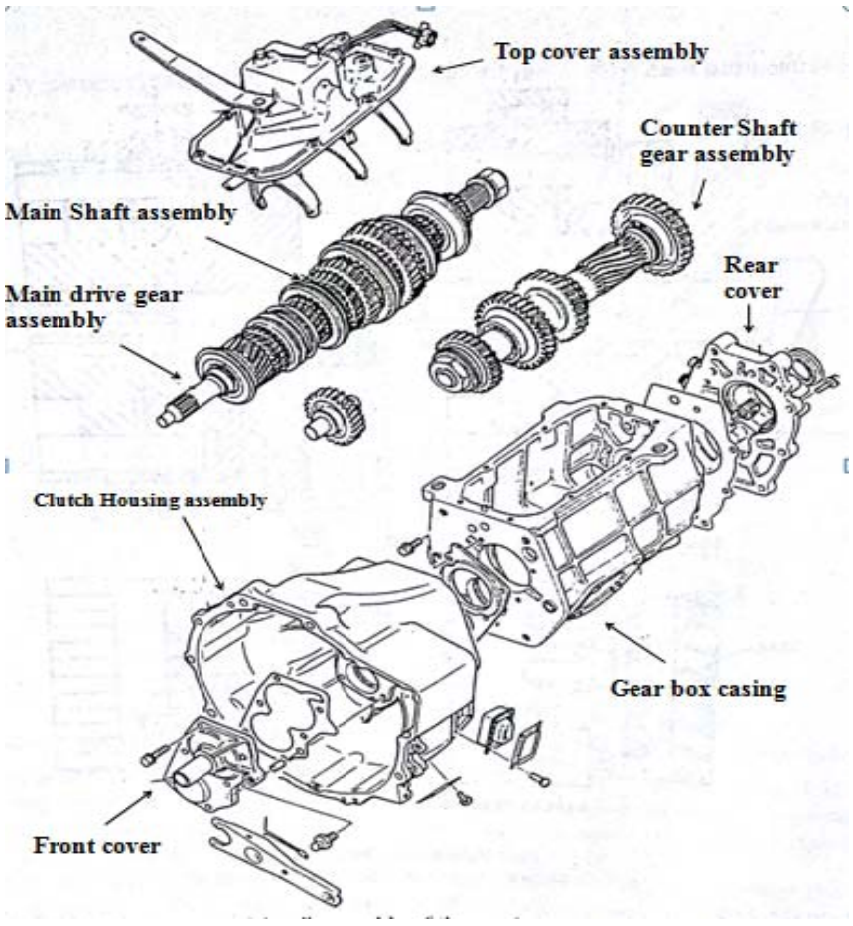

Figure 5.3: Disassembly of the Synchromesh gear box

Figure 5.4: **Working Model of Synchromesh Gear box**

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity
1.	Cut-section working model/Actual unit of Synchromesh gear box	Five speed synchromesh gear box used in car/ light motor vehicle/heavy motor vehicle.	1
2.	Basic hand tools	Open end spanner set, Ring spanner set, Socket spanner set, Ball pin Hammer, Pliers, Screw driver.	1
3.	Measuring tools & Gauges	VernierCaliper/Micrometer screw gauge, Feeler gauge.	1
4.	Torque wrench	Torque wrench with square drive and scale.	1
5.	Pullers	Two-arm puller, Ball bearing extractor	1

X Precautions to be Followed

- Refer the appropriate service manual
- Use Specified tools, special tools and other equipments.

XI Procedure

- **Dismantling :**

1. Mount the gearbox on the work stand. Remove the selector assembly
2. Lock the main shaft by engaging any two gears by shifting the respective sliding sleeve.
3. Remove the driving flange. Remove the gear box rear end cover.
4. Remove the speedometer drive gear. Remove the end covers. Remove the clutch shaft. Pull out the main shaft along with the bearing.

5. Remove the main shaft gears, dog clutch, sliding sleeve, synchromesh unit, bearings and arrange these in the order of their fitment on the main shaft.
6. Remove the reverse idler gear shaft and the idler gear. Remove the lay shaft gear set with washers. Remove the lay shaft bearings.

- **Inspection :**

1. Inspect the transmission case for cracks and worn or damaged bearing bores and threads.
2. Check each synchronizer sleeve for free movement on its hub.
3. Check the amount of synchronizer ring wear by placing the ring on its gear cone.
4. Inspect the shift fork and groove in the synchronizer sleeve for wear or damage.
5. Check all bushings and bearings
6. Inspect all gears for crack or worn out excessively.

- **Assembling :**

1. Place all seats in the cover. Fit the counter shaft bearing.
2. Clamp the counter shaft in its position. Fix the reverse idler along with its shaft and lock it.
3. Assemble the gears, bushes, dog clutches, synchromesh units on the main shaft.
4. Place the plot bearing on the main shaft.
5. Lift the main shaft & place it in the gearbox casing. Fit the main shaft rear end bearing inside the casing.
6. Fix the bearing on clutch shaft & fit a circlip. Place the clutch shaft in the casing. Place the bearing housing along with the gasket on gear casing.
7. Place the speedometer drive gear on the main shaft. Fit all the bearing covers along with the gasket.
8. Place the drive flange on main shaft. Keep the main shaft in neutral position. Keep all the forks in neutral position.
9. Mount the selector assembly on gearbox.
10. Engage each gear and check the rotation by hand

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations and Calculations :

a) Note: Identify the driver and driven gears for different gear ratios during dismantling and count the number of teeth on respective gears. Calculate the gear ratios.

Sr. No.	Gear position	No. of teeth on		Gear Ratio
		Driven gear	Driver gear	
1	First			
2	Second			
3	Third			
4	Forth			
5	Fifth			
6	Reverse			

b) i) Observe the Synchromesh unit and state whether they are single / double / three stage Synchromesh unit

ii) The gears on the layshaft are ---------- (fixed / movable)

iii) The gears on the Main shaft are ---------- (fixed / movable)

XVI Results

Gear ratio obtained for a given vehicle

1. Fist gear = ……..……
2. Second gear = …….
3. Third gear =……..
4. Fourth gear =……
5. Fifth gear =……..
6. Reverse gear=……..

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is the purpose of gear box?
2. Describe principle of Synchromesh gear box.
3. Describe the constant mesh gear box with the help of sketch.
4. What are the advantages of a synchronizing mechanism?
5. What are the possible causes and remedies of hard gear?

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=VcFQZ8NiF4o
2. https://www.youtube.com/watch?v=0Bqs-oHBBQk

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. …….
2. …….
3. …….
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 6 : Dismantle, inspect and reassemble the Propeller Shaft Assembly.

I Practical Significance

The propeller shaft transmits power from the gearbox to the rear axle, accommodates change in length, and transmits motion at varying angles. It is connected between the gear box side universal joint and differential unit side universal joint. Hence it is significant to understand the constructional details of propeller shaft and universal joint assembly and demonstrate its working for finding the faults and related causes. In this practical we use actual working unit of propeller shaft and universal joint for dismantling, inspection and assembling purpose.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

PO8 -**Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual.

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Inspect given component assembly of the given vehicle

V Practical Outcome

- Dismantle, inspect and reassemble the Propeller shaft Assembly

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

In an automobile, the shaft which transmits the power from the gearbox output shaft to final drive (differential) is called as a propeller shaft. The propeller shaft is normally tubular in section and of one or two-piece construction. It consists mainly of three parts :

a. **Shaft:** - As the shaft has to withstand mainly torsional loads, it is usually made of tubular cross-section. The shaft has to be well balanced to avoid whirling at high speeds. Shaft is made of steel, aluminium or composite materials.

b. **Slip joint**: - Depending upon the type of the drive, one slip joint may be there in shaft. This serves to adjust the length of the propeller shaft when demanded by the rear axle movement. Slip joint is formed by the internal splines on the sleeve attached to the left universal joint and external splines on the propeller shaft.

c. **Universal joints**: Depending upon the type of the rear axle one or two universal joints is used. The universal joints account for the up and down movements of the rear axle when the vehicle is running.

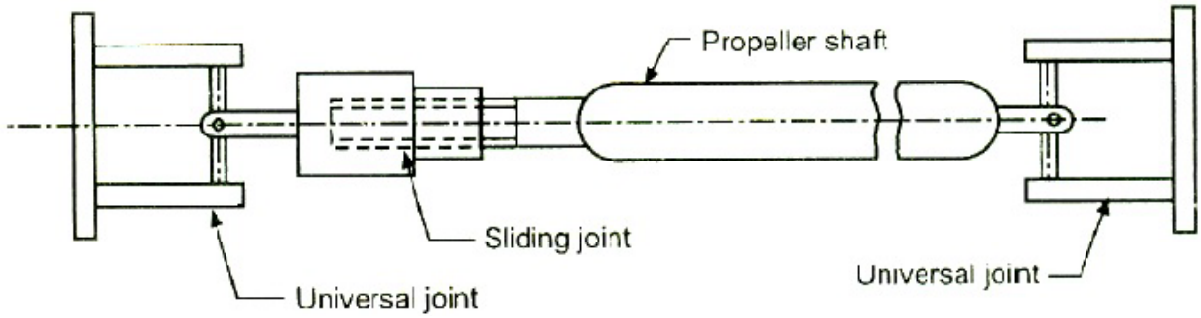

Figure 6.1: Propeller shaft

VIII Experimental setup / Practical Diagram

Figure 6.2: Propeller shaft assembly

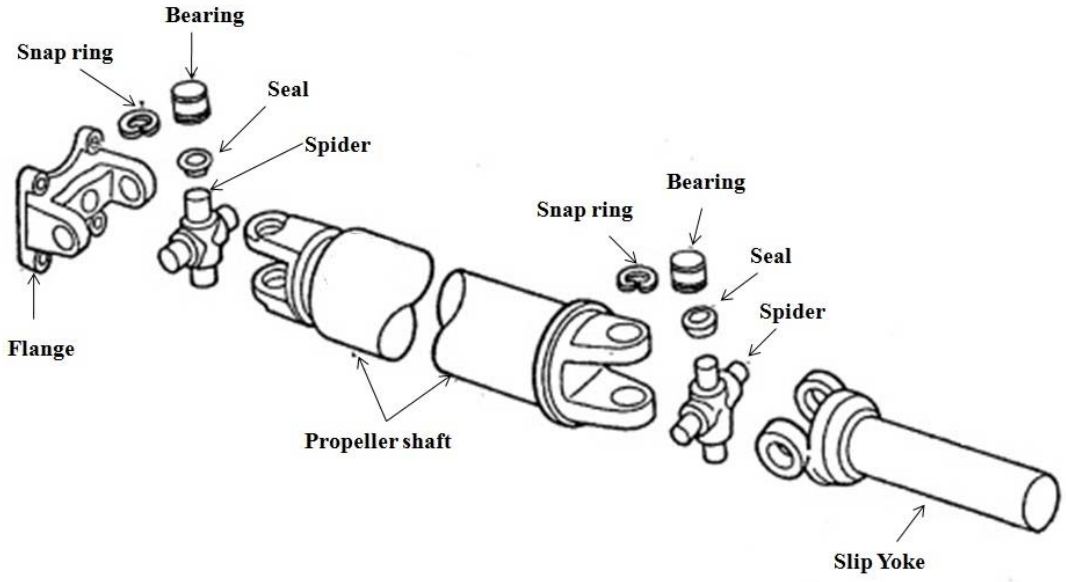

Figure 6.3: Exploded view of Propeller Shaft

IX Resources Required

Sr. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Propeller shaft	Rear Hollow propeller shaft with two universal joints and a sliding joint used in LMV.	1	
2.	Universal joint	Type- Cross & Yoke type universal joint with needle roller bearings.	1	
3.	General & Special purpose tools	Make: Taparia /Stanley	1	

X Precautions to be Followed

- Refer the appropriate service manual
- Use Specified tools, special tools and other equipments.

XI Procedure

- **Dismantling:**

1. Before removing the shaft, it is necessary to mark the end flanges so that they can be refitted in the same position.
2. Disconnect the joints at the both ends and remove the shaft.
3. Remove the dust cover on the sliding joint and separate the two parts.
4. Before dismantling the universal joint make match marks on the yoke and propeller shaft. Clamp the universal joint assembly in a bench vice using soft jaws and remove the circlips.
5. Then with soft drift, gently tap from above so that needle bearing on the lower side falls out.
6. Reverse the joint and drive out the bearing.

- **Inspection :**
  Inspect the bearing, journal trunnions and the splines of sliding joint for wear. If there is sign of wear or excessive looseness found replace the different parts.

- **Assembling:**

1. Grease the various rollers and assemble the needle bearings.
2. Replace the gaskets and fit the journal and bearing trunnions to the yokes.
3. Install the circlips.
4. Screw the dust cover and slide in the slip joint.
5. Lubricate the various joints with specified lubricant.
6. Place the reassembled propeller shaft in position in the chassis, insert the bolts in the flanges and tighten them

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations

The student should inspect all the components of Propeller shaft assembly as instructed and write the observations :

S.N.	**Component**	Remark / Function
1	Yoke	
2	Spider	
3	Slip joint	
4	Bearing	

5.	Snap ring	
6	Flange	
7	Shaft	

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is the function of universal joints to power transmission?
2. What is the purpose of slip joint?
3. Why are two universal joints required?
4. Name the two types of propeller shaft and describe one type in detail.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=FKBB7DtuxmY
2. https://www.youtube.com/watch?v=Z_u5tTtCnt8

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 7 : Dismantle, inspect and reassemble the Differential Assembly

I Practical Significance

The purpose of final drive is to provide a permanent speed reduction and also to turn the drive through 90^0. Differential mechanism differentiates the power and facilitates the vehicle to take a turn safely. Hence it is significant to understand the constructional details of differential and rear axle for finding the faults and identify the causes for the same. In this practical we use actual working unit or cut-section working model of differential rear axle for dismantling, inspection and assembly purpose.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices touse the results to solve broad-based Mechanical Engineering problems.

PO8 -**Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipment for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Select service tools for relevant service operation in automobile shops

V Practical Outcome

- Dismantle, inspect and reassemble the Differential Assembly

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

It is a geared mechanism located between the two driving axles. It rotates the driving axles at different speeds when the vehicle is turning a corner. It also allows both axles

to turn at the same speed when the vehicle is moving straight. This is also known as the final drive, and consists of just two gears. It is required because of the speed at which an engine runs, and in order to produce enough torque at the road wheels, a fixed gear reduction is required. These are fitted after the output of the gearbox, on front wheel drive, or in the rear axle after the propeller shaft on rear wheel drive vehicles.

- **Working Principle of Differential:**

If a vehicle travels in a straight line, the two rear wheels turn exactly at the same speed, and there is no relative movement between them. But when the vehicle takes a turn the outer wheel travels a longer radius than the inner wheel. i.e. there is relative movement between the two rear wheels. If the two rear wheels are rigidly fixed to the rear axle. The inner wheel will slip which will cause rapid tyre wear, steering difficulty and poor road holding. Therefore there must be some device to provide the relative movement to the rear wheels when vehicle is taking turn.

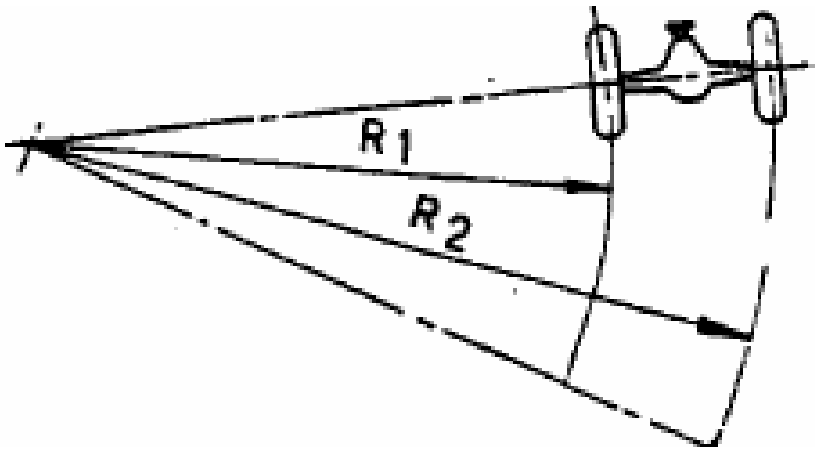

Figure 7.1: Principle of differential

- **Construction and working of Differential :**

The crown wheel of the final drive is attached on a cage which carries a crosspin. Two sun gears mesh with the two planet pinions. Axle half-shafts are splined to each of these sun gears. The crown wheel is free to rotate on the half-shaft .

When the vehicle is going straight the cage and the inner gears rotate as a single unit and the two half shafts revolve at the same speed. In this situation, there is no relative movement among the various differential gears. To understand what happens when the vehicle is taking a turn, assume that the cage is stationary. Then turning one sun gear will cause the other to rotate in the opposite direction. That means if left sun gear rotates 'n' times in a particular time, theright sun gear will also rotate n times in the same period but, of course, in the opposite direction. This rotation is super-imposed on the normal wheel speed when the vehicle is taking a turn. Thus the outer wheel rotates at higher speed than the inner wheel while taking a turn.

VIII Experimental setup / Practical diagram

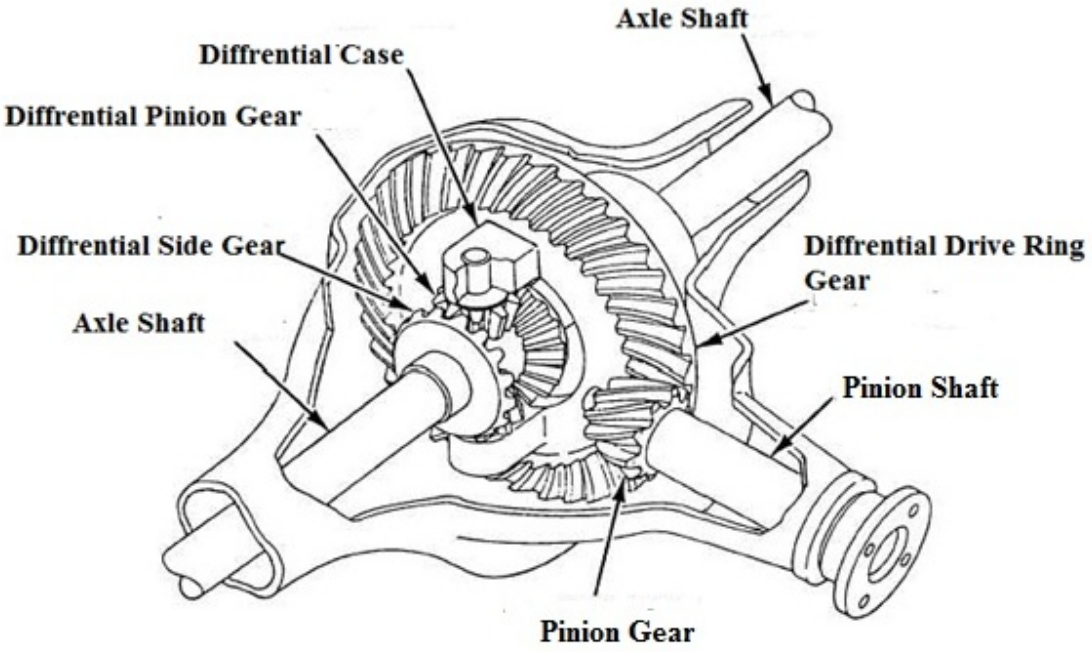

Figure 7.2:Differential Assembly

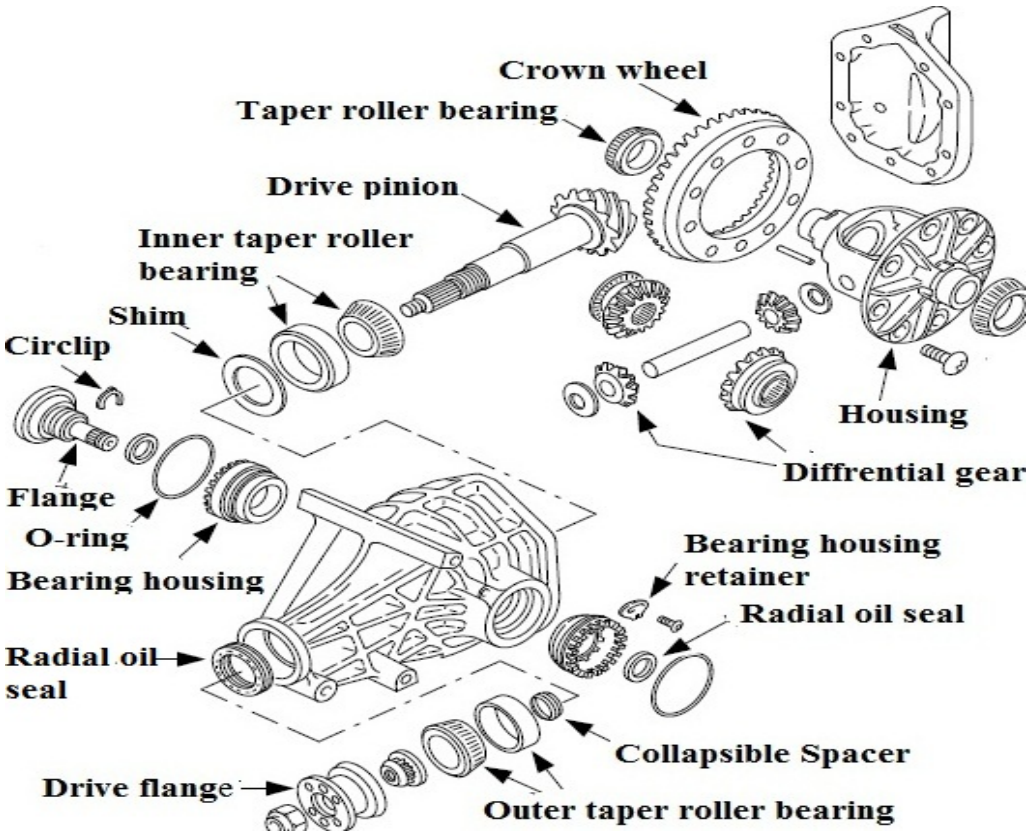

Figure 7.3: Exploded view of Differential assembly

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Cut-section working model/Actual unit of Differential assembly	Model of open type differential	1	
2.	General & Special tools	Hand Tools, Measuring Tools, Special service tools.	1	

X Precautions to be Followed

- Proper tools to be used and sequence to conduct each exercise.
- Refer the appropriate service manual to carry out Dismantling , inspection and assembling.

XI Procedure

- **Dismantling :**

1. Mount the differential assembly on a stand. Drain off the oil by unscrewing the oil level check plug.
2. Detach the housing cover.
3. After the cover has been removed, remove pinion shaft lock bolt.
4. Remove pinion shaft.
5. Remove two spider gears and two axle side gears.
6. Push axles in and remove C-clips.Remove axles.
7. Mark and remove case caps.
8. Using a case spreader or two pry bars, pry up and remove carrier case keeping the shims separate.
9. Remove pinion shaft nut and washer. Discard the nut.
10. Mark and remove companion flange with suitable puller.
11. Remove front pinion seal and front pinion bearing.
12. Using suitable punch, drive pinion gear rearward until it is free of housing.

- **Inspection:**

1. Inspect each tooth for any pitting or broken tip on crown wheel, pinion, sun gear and planetary pinion.
2. Check the backlash**.**
3. Check the crown wheel run out.

- **Assembling :**

1. Place, position, install, press and assemble all the spare parts as needed in the reverse order of dismantling.
2. Fix back differential assembly in axle housing with new gasket & tighten all nuts. Fill oil in differential assembly up to the specified oil level.
3. Install the rear axle driveshaft flanges.
4. Fix the differential cover.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations :

1. The differential is a mechanism fitted after ……... (Propeller/gearbox)
2. Differential transmit power at right angle to …….
3. The speed of inner and outer wheels is differentiated while …….. (Moving straight/taking a turn).
4. In the differential the crown wheel is meshed to ……. (drive pinion / axle shaft).
5. The axle half shaft is splined to the…….(Sun gear, planet pinion, crown wheel& pinion gear)

Components of differential

S.N.	Components	Write Location and function of the components
1	Bevel pinion	Location- Function-
2	Sun gear	Location- Function-

3	Cage	Location- Function-
4	Bearing	Location- Function-
5	Rear axle-half shaft	Location- Function-
6	Crown wheel	Location- Function-
7	Pinion gear	Location- Function-

XVI Results

Final Drive ratio = $\frac{\text{No.of teeth on crown wheel}}{\text{No.of teeth on bevel pinion}}$ = ……..

XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the function of differential unit .
2. List the components of differential.

3. Identify bearing locations in differential and state type of bearing used.
4. Draw a sketch of final drive of dismantled differential and label it

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=SOgoejxzF8c
2. https://www.youtube.com/watch?v=WmZhcVNmU-o

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
Total (25 Marks)		**100 %**

Names of Student Team Members

1. ……
2. …….
3. …….
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 8 : Dismantle, inspect and reassemble the Drum/Disc Brake.

I Practical Significance

The purpose of the braking system is to slow down or stop the vehicle and when the vehicle is stationary, to hold the vehicle in the chosen position.In this practical we use actual working unit or cut-section working model of drum / disc brake for dismantling , inspection and assembly purpose.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO2 - Discipline knowledge: Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

PO8 -**Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component /assembly of the given vehicle.

IV Relevant Course Outcome(s)

- Select service tools for relevant service operation in automobile shops

V Practical Outcome

- Dismantle, inspect and reassemble the drum / disc brake.

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Maintain tools, equipment and service records

VII Minimum Theoretical Background

When a vehicle is moving it contains energy of motion (kinetic energy) and the function of the braking system is to convert this kinetic energy into heat energy. It does so through the friction at the brake linings and the brake drum, or the brake pads and the disc.

Two basic types of friction brakes are in common use on vehicles; these are:

1. Drum brake

2. Disc brake

Both types use a fixed (non-rotating) shoe or pad that rubs against a moving drum or disc. The friction between the rubbing surfaces is increased by attaching a special friction material to the fixed component (i.e. brake pad or shoe).

- **Drum brake:**

In these type of brakes a brake drum is attached concentric to the axle hub whereas on the axle casing is mounted a back plate. Two brake shoes are anchored on the back plate. Friction linings are mounted on the brake shoes. One or two retractor springs are used which serve to keep the brake shoes away from the drum when brakes are not applied. The brake shoes are anchored at one end whereas on the other ends Force F is applied by means of some brake actuating mechanism which forces the brake shoe against the revolving drum,thereby applying the brakes.

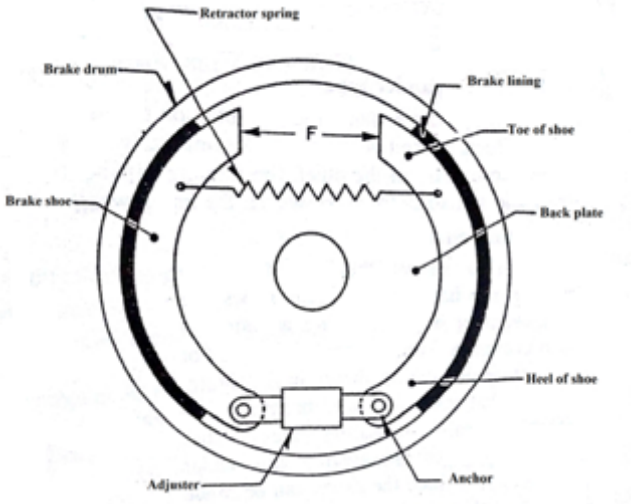

Figure 8.1: Drum brake

- **Disc brake**:

These brakes consist of a metal disc and a pair of pads. The disc is attached to the wheel hub by bolts. The caliper is connected to the axle casing or stub axle. The caliper is cast in two parts, each part containing a piston. There is a friction pad in between each piston and the disc.

The passages are drilled in the caliper for the fluid to enter or leave the housing. These passages are also connected to another one for bleeding. There is a rubber sealing ring between each cylinder and the piston . In a disc brake, the fluid from the master cylinder is forced into a calliper where it presses against a piston. The piston in turn crushes two brake pads against the disc that is being attached to wheel, making it to stop or slow down.

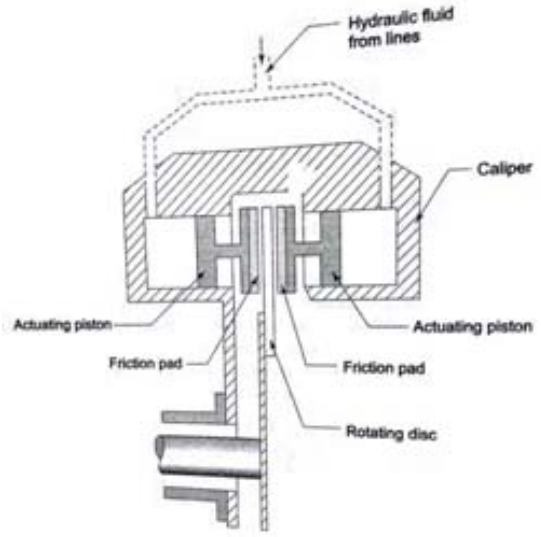

Figure 8.2: Disc brake

VIII Experimental setup / Practical diagram

Figure 8.3 : Drum brake assembly

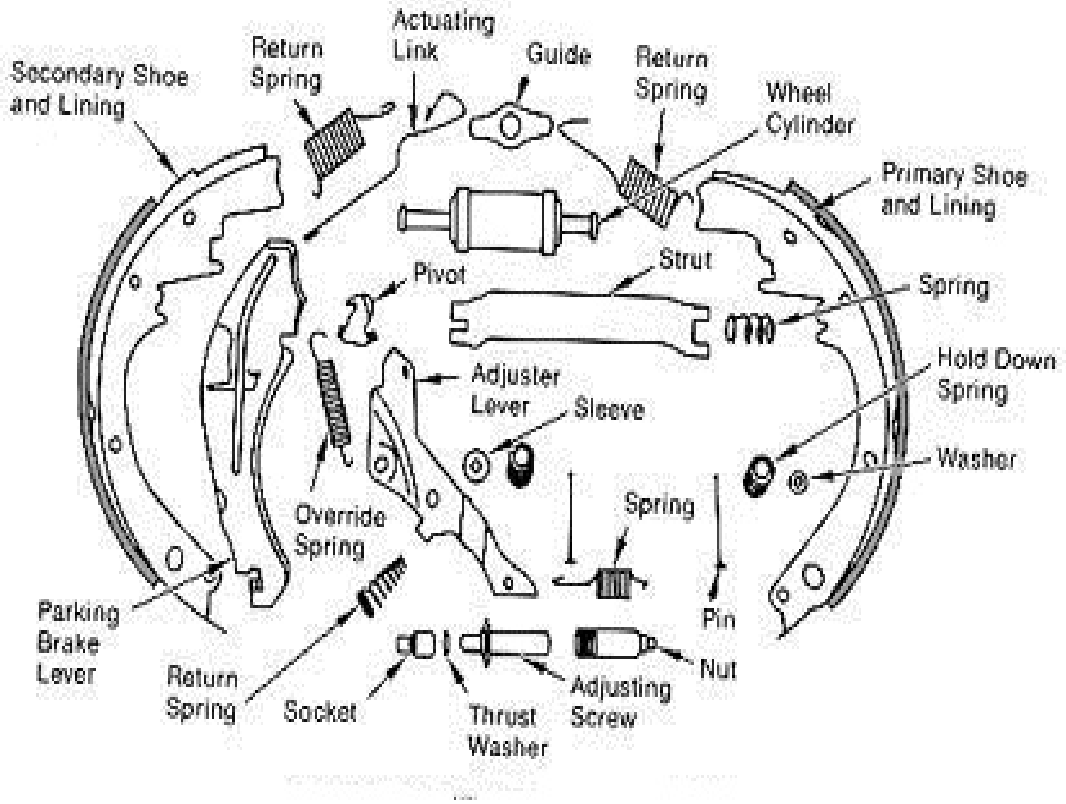

Figure8.4 : Exploded view of Drum brake

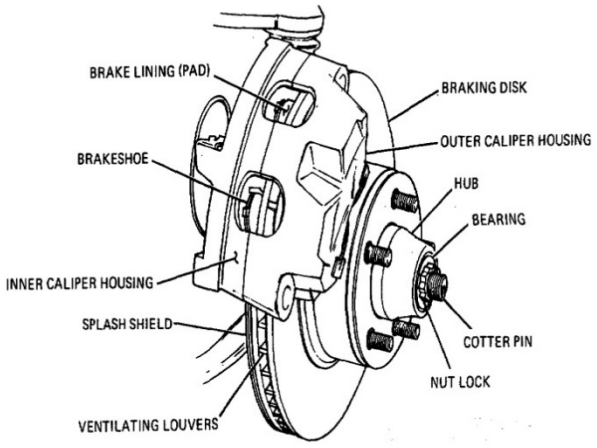

Figure 8.5 : Disc brake assembly

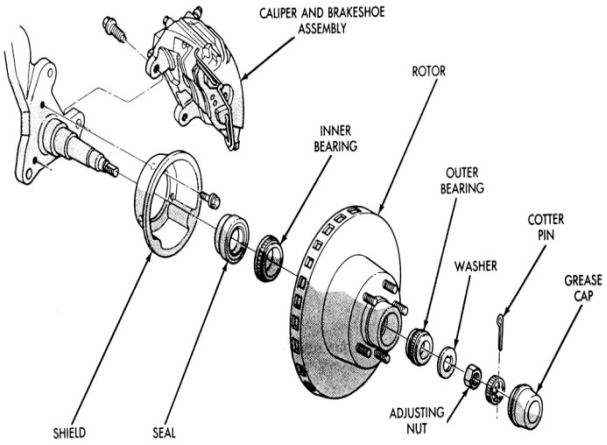

Figure 8.6 :Exploded view of Disc brake

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity
1.	Demonstration working model of Drum / Disc Brake	Model of Drum Brake (Mechanical/Hydraulic Linkage) Model of Disc Brake (Hydraulic Linkage)	1
2.	General & Special tools	Hand Tools, Measuring Tools, Special service tools.	1

X Precautions to be Followed

- Proper tools to be used and sequence to conduct each exercise.
- Refer the appropriate service manual to carry out Dismantling ,inspection and assembling

XI Procedure

Drum Brake

- **Dismantling:**

1. Raise and safely support the vehicle.
2. Remove the wheel from the vehicle.
3. Apply the parking brake and remove
4. Remove the attaching nuts.
5. Release the parking brake and remove the brake drum.
6. Remove the spring from the secondary shoe to the adjusting lever.
7. Remove the adjusting lever, return spring, and hold down pin clips.
8. Remove the primary shoe.
9. Disconnect the C- clip and pin attaching the parking brake lever to the secondary brake shoe.

- **Inspection:**

1. Check Inside of the drum for excessive wear, damage, and cracks.
2. Shoe sliding surface for excessive wear and damage
3. Check back plate for damage, cracks, and deformat
4. ion
5. Check wheel cylinder for brake fluid leakage

- **Assembling :**

1. Lubricate the backing plate contact points.
2. Connect the parking brake lever to the secondary brake shoe.
3. Attach the primary and secondary brake shoe to the backing plate.
4. Install the return spring, adjusting lever.
5. Install the brake drum and retaining nuts.
6. Install the wheels and lower the vehicle.

Disc Brake

- **Dismantling:**
  1. Hold down the wheels of the vehicle. One or two wheel nuts can be loosened.
  2. Jack up the wheel and remove safely.
  3. Remove the dust boots on both sides of the slide bush.
  4. Remove the disc brake caliper and carrier.
  5. Remove the disc brake pads. Dissemble the brake caliper.
  6. Disconnect the brake pipe line and remove the piston with piston seal

- **Inspection :**
  1. Check piston surface for corrosion, wear, and damage. Replace piston as necessary.
  2. Check sliding pins, sliding pin bolts and sliding pin boots for wear, damage, and cracks. Replace applicable part as necessary.
  3. Using a micrometre, check thickness of disc rotor. If thickness is outside the standard, replace disc rotor.

- **Assembling :**
  1. While assembling , dip each part in clean brake fluid.
  2. While fitting the piston and the piston seal to the cylinder apply some amount of brake fluid to them
  3. Fix the piston seal and insert the piston .
  4. Fix the dust boots on both sides of the slide bush.
  5. Fix bleeder screw , brake pads and disc brake calliper . connect the brake pipe line.
  6. Bleed the system and test it

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations :

Drum Brake components

S N	**Component**	Remark / Function
1	Brake Drum	
2	Brake shoe	
3	Wheel cylinder	
4	Backing Plate	
5.	Adjusting Screw	
6	Return spring	

Drum Brake Troubleshooting

S N	**Drum brake Fault**	**Causes**	**Remedies**
1	Brake fade		
2	Brake chatter		
3	Brakes grab		
4	Brake drum wear		

Disc Brake Components

S N	**Component**	Remark / Function
1	Rotor	
2	Hub	
3	Caliper	
4	Brake pads	
5	Piston	
6	Rubber sealing ring	

Disc Brake Troubleshooting

S N	**Disc brake Fault**	**Causes**	**Remedies**
1	Brake noise		
2	Caliper cylinder leakage		
3	Brake pedal is pressed without braking action		
4	Excessive pedal travel		

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. What is the principle of automotive brakes?
2. What are the important differences between mechanical and hydraulic brakes?
3. Compare disc and drum brake.
4. Name important components of brake drum.
5. Out of disc and drum brakes, which have better anti-fade characteristics?

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=80sjvvdj-sg
2. https://www.youtube.com/watch?v=g5n8OqS1Fow

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of service tool carefully	20%
2	Select the sequence of operation of dismantle and assembly	20%
3	Safety measures and standard practices	20%
Product Related (10 Marks)		**(40%)**
5	Interpretation of result , Conclusion	20%
6	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……
2. …….
3. ……
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No. 9 : Dismantle, inspect and reassemble the Steering Gear Box. (Rack &Pinion/Re-Circulating Type/Worm And Wheel)

I Practical Significance

Steering system of a vehicle is an essential system of vehicle. When a vehicle is steered manually, the driver provides all the steering force. Then through the mechanical advantage of the steering gear and linkage, the front wheels are steered to the right or left as desired by the driver.

Steering system operation enables a driver to control vehicle direction and motion. Inspection and maintenance of steering gear box is essential.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO 2-**Discipline knowledge:** Apply mechanical engineering knowledge to solve broad-Based mechanical engineering related problems

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

PO4 **-Discipline knowledge:** Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component/ assembly of the given vehicle

IV Relevant Course Outcome(s)

- Select suitable braking and steering systems for different applications.

V Practical Outcome

- Dismantle, inspect and reassemble the Steering Gear box. (Rack & Pinion/ Re-circulating Type/Worm and Wheel)

VI Relative Affective Domain-

- Practice good housekeeping.

VII Minimum Theoretical Background

The Steering gear box increases the mechanical advantage while changing the rotary motion of steering wheel to linear motion. The steering linkage carries the linear motion to the steering arms. The rack-and-pinion steering gear has become

increasingly popular on smaller passenger vehicles. It is simpler, more direct acting, and may be straight mechanical or power-assisted.

The manual rack-and-pinion steering gear basically consists of a steering gear shaft, pinion gear, rack. Thrust spring, bearings, seals, and gear housing. In the rack-and-pinion steering system the end of the steering gear shaft contains a pinion gear, which meshes with a long rack. The rack is connected to the steering arms by tie rods, which are adjustable for maintaining proper toe angle. The thrust spring preloads the rack-and-pinion gear teeth to prevent excessive gear backlash. Thrust spring tension may be adjusted by using shims or an adjusting screw.

As the steering wheel is rotated, the pinion gear on the end of the steering shaft rotates. The pinion gear moves the rack from one side to the other. This action pushes or pulls on the tie rods, forcing the steering knuckles or wheel spindles to pivot on their ball joints. This turns the wheels to one side or the other so the vehicle can be steered.

VIII Experimental setup

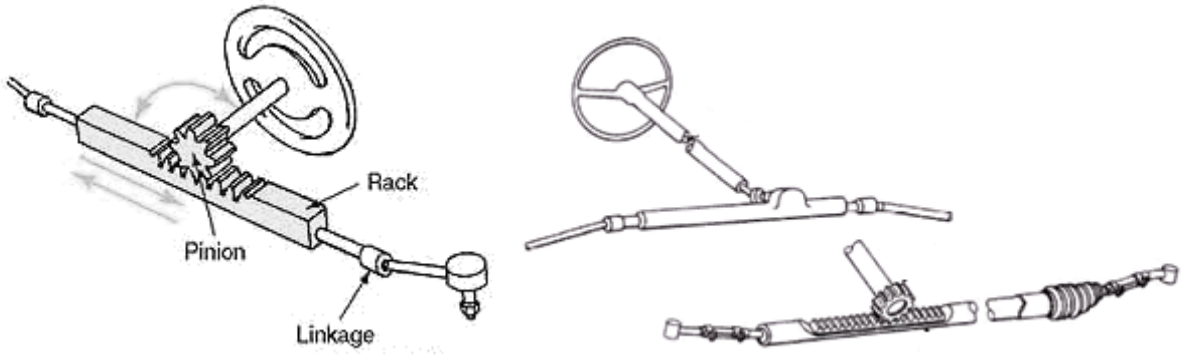

Figure No 9.1: Simplified and actualview of Rack and Pinion steering System Linkages

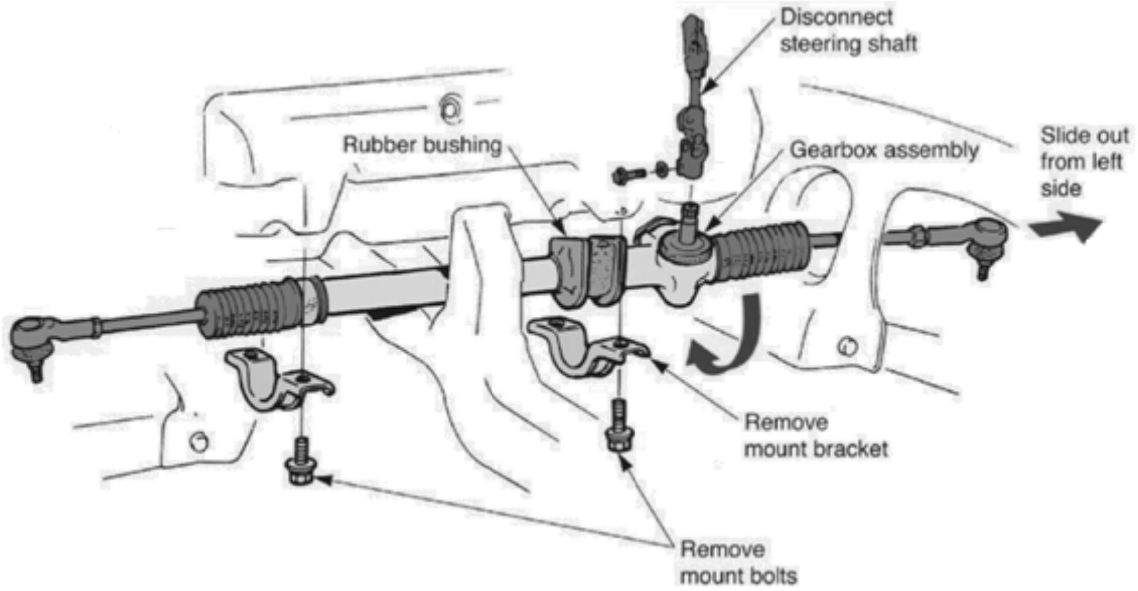

Figure No. 9.2:Manual Rack and Pinion Gearbox removal

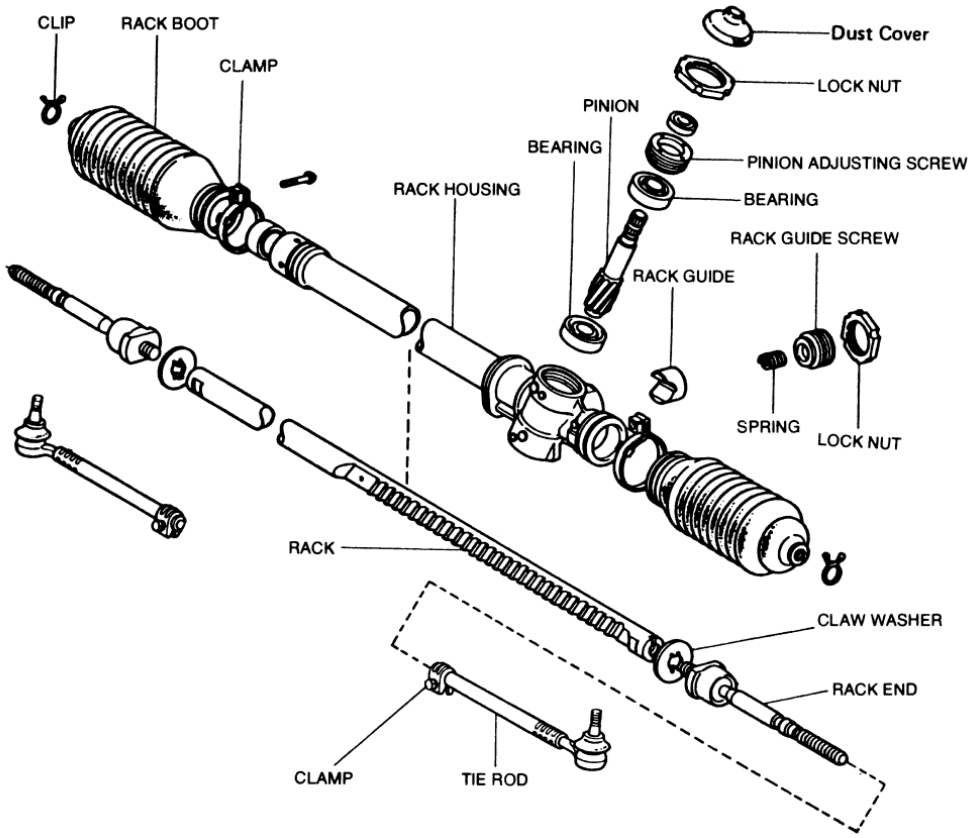

Figure No 9.3: Rack and Pinion Steering Gear Exploded View

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Car with rack and pinion steering gear	Maruti 800 car OrCar having Rack and pinion Steering gear/ re-circulating ball Type/Worm and Wheel type gear.	1
2.	Hand tools and special tools	Hand tools: Pipe wrench. Tie rod puller and other tools,Ball Joint Extractor and Separator fork set Special Tools: Torque Wrench	1 each
3.	Puller set	Puller set for steering wheels, sprockets, Pulleys and shafts. Range Ø 32 to Ø 90 mm with spindle	1 set
4.	Steering wheel puller	Steering wheels which are stuck on steering column may be pulled off clearly and without damage to the steering column and steering wheel with the puller.	1 set
5.	Mounting tool set	The toolset allows a quick and easy removal and replacement of inner steering ball joint without the need to dismantle steering rack from the bulkhead. Drive head Range Ø 35 to Ø 39 mm	1 set
6.	Alignment tool set	As per available vehicle service manual specifications	1 set

X Precautions to be Followed

1. Avoid improper handling of hand tools and special tools
2. While operating under the vehicle, ensure use of Personal Protective equipments.
3. Keep in mind the right hand threads and left hand threads at tie rods.

XI Procedure

Dismantling

1. Refer to the Original equipment manufacturers service manual for exact procedures and instructions. Steering gearbox may be rebuilt using standard service manual procedure.
2. Disconnect the negative battery cable. Remove the upper and lower steering column covers.
2. Disconnect universal joint from the gear housing. Place matchmarks before removing set bolts.
3. Raise and safely support the vehicle.
4. Remove both front wheels.
5. Remove the cotter pins from both tie rod joints and remove the nuts.
6. Using a tie rod separator, remove both tie rod joints from the steering knuckles.
7. Support the engine assembly and remove the engine mounting, lower the engine if necessary.
8. Remove the nuts and bolts attaching the steering rack to the body.
9. Remove any other necessary component to gain working access (if possible slide assembly out the wheel well opening) to remove the rack and pinion assembly from the vehicle. Remove the rack assembly.

Inspection:

10. Inspect rack and pinion for undue wear.
11. Grasp the tire and feel for looseness in the inner tie rods. If looseness is detected, check under the bellows to verify the inner tie rod is loose. If an inner tie rod is loose, replace the gear.
12. Inspect the bellows for damage, and replace if needed. See the vehicle workshop manual for replacement instructions.

Assembling:

13. Install the rack assembly. Secure it with the retaining bolts and nuts and tighten them EVENLY to 58 Nm.
14. Connect the tie rods to each steering knuckle. Tighten the nuts to 48 Nm and install NEW cotter pins. Wrap the prongs of the cotter pin firmly around the flats of the nuts.
15. Install the front wheels.
16. Lower the car to the ground.
17. Align matchmarks and connect universal joint to the steering gear housing. Tighten the upper and lower set bolts to 35 Nm.
18. Install the steering column cover. Reconnect the negative battery cable. Check front wheel alignment.

Adjustment procedure:

1. Using torque wrench or spring scale, measure amount of force needed to turn steering wheel or worm shaft to center position.
2. Compare your measurement to specifications. If needed, loosen worm adjuster locknut.

3. Tighten worm bearing adjuster to increase preload or loosen adjuster to decrease preload.
4. Tighten locknut and make sure steering wheel or shaft turns freely from stop to stop
5. If it binds or feels rough, gearbox is damaged and should be rebuilt or replaced.
6. Adjust pitman shaft over-center clearance – controls amount of play between pitman shaft gear and teeth on ball nut.
7. Find center position of steering wheel or worm shaft.
8. Loosen adjustment screw locknut. Turn in over- center adjustment screw until it bottoms lightly. This will remove backlash.
9. Measure amount of force needed to turn steering wheel or gearbox worm shaft- use torque wrench or spring scale for this measurement.
10. Compare your measurement to specifications
11. Loosen or tighten adjustment screw as needed to meet the specifications.
12. Tighten the locknut and recheck gearbox action.
13. Steering gearbox overhaul is done by dismantling, cleaning, inspecting and replacing parts as needed.
14. Replace all worn parts and rubber seals.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
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XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations

Parameter	Observation	Specification	Remark
Force needed to turn steering wheel (Using spring scale)			

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Describe bearing preload procedure and its necessity.
2. Justify the need of steering wheel locking in place_ during service.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=vawb-2xM8Jk Replace steering gear box
2. https://www.youtube.com/watch?v=B4CfK8E5LnA how to replace a steering gear box
3. https://www.youtube.com/watch?v=CSSibRlcoiY how to adjust a steering gear box.

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of tools and special tools	20%
2	Observations	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 10 : Dismantle, inspect and reassemble the Power Steering System. (Hydraulic/ Electronic Type)

I Practical Significance

Power steering is very important for safe driving. Power steering has a hydraulic pump that transmits fluid to the steering system to assist driver in turning vehicle steering wheel easily. Without the power assistance system it would be very difficult to turn the vehicle. Over time, fluid breaks down due to heat and contamination which can cause the rubber and nylon o-rings, seals and hoses to break down and possibly break.

One should check the power-steering fluid reservoir monthly to make sure it has the proper amount and that the power-steering system isn't leaking. Reservoirs on many vehicles are the see-through plastic type, so you don't even have to remove a cap to check the level. Refer owner's manual for the location of the reservoir in the engine compartment for help. One also should check the manual for the type of power-steering fluid that is required.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basicEngineeringto solve the broad-based Mechanical Engineering problems.

PO 2-**Discipline knowledge:** Apply mechanical engineering knowledge to solvebroad- basedmechanicalengineering related problems

PO3 - **Experiments and practice:**Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

PO4 -Discipline knowledge: Apply mechanical engineering knowledge to solve broad-basedmechanicalengineering related problems

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component/ assembly of the given vehicle

IV Relevant Course Outcome(s)

- Select suitable braking and steering systems for different applications.

V Practical Outcome

- Dismantle, inspect and reassemble the Power Steering system. (Hydraulic/ Electronic Type)

VI Relative Affective Domain-

- Practice good housekeeping.
- Practice energy conservation.
- Maintain tools, equipment and service records.

VII Minimum Theoretical Background

Large amount of torque is required to be applied by the driver for steering of medium and heavy vehicles. The power steering system provides automatic hydraulic assistance to the tuning effort applied to the manual steering. The power steering system is operated when the effort at the steering wheel exceeds a predetermined value (about 10 N). If it fails, the drive is able to steer the vehicle manually with increased effort. In this system, a continuously operating pump provides hydraulic pressure when needed. As the steering wheel is turned, valves are operated to admit this hydraulic pressure to a cylinder that contains the power piston. Then the pressure causes the piston to move, and it provides most of the steering force.

VIII Experimental setup

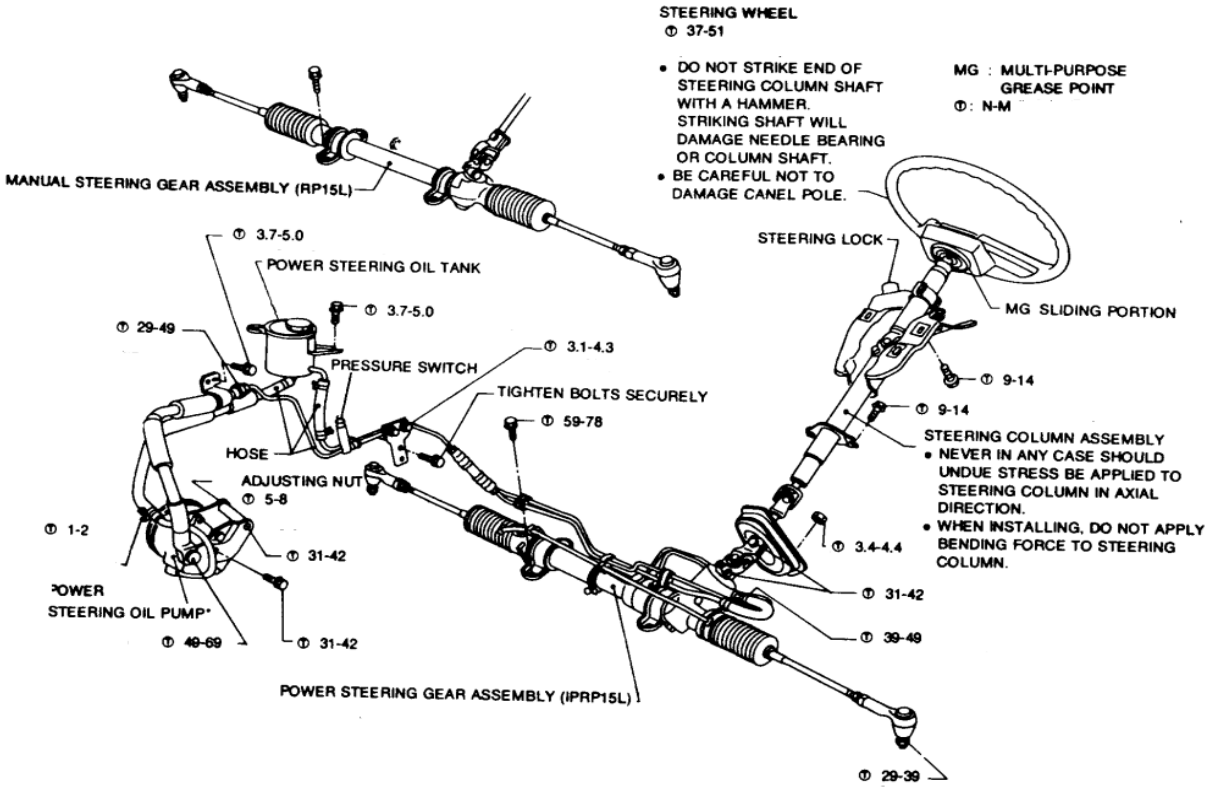

Figure 10.1: Hydraulic Power steering gear with applicable torque and lubrication

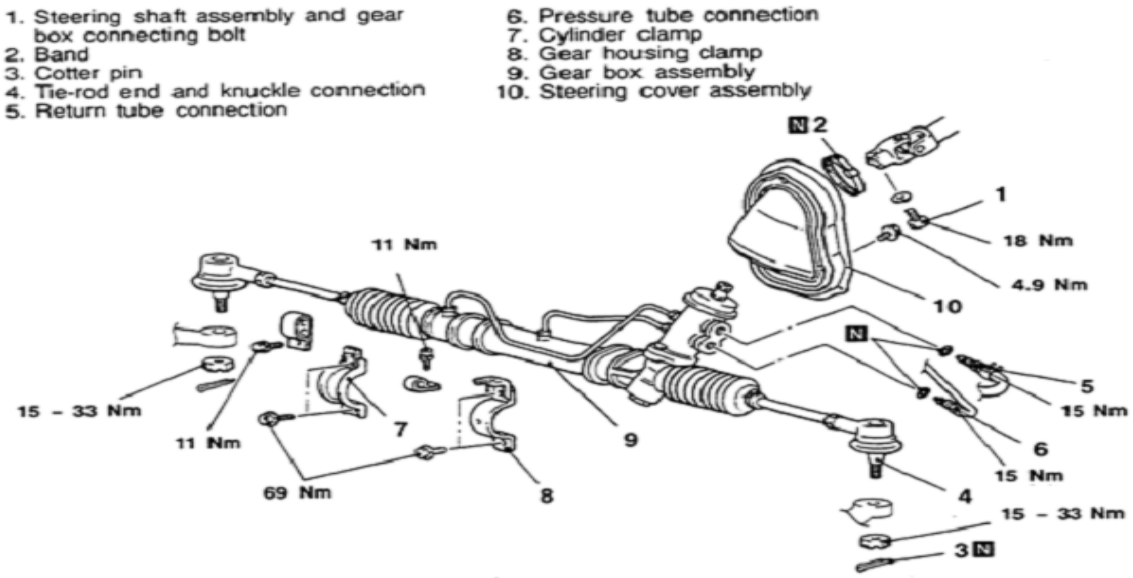

Figure 10.2: Hydraulic Power steering gear Part list

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Car with power steering gear (or re-circulating Type/Worm and Wheel)	Maruti 800 car Or Car having Power steering gear -Rack and pinion or other type of Steering gear	1
2.	Hand tools and special tools	Hand tools: Pipe wrench. Tie rod puller and other tools,Ball Joint Extractor Separator fork set. Special Tools: Torque Wrench	1 each
3.	Puller set	Puller set for steering wheels, sprockets, Pulleys and shafts. Range Ø 32 to Ø 90 mm with spindle	1 set
4.	Steering wheel puller	Steering wheels which are stuck on steering column may be pulled off clearly and without damage to the steering column and steering wheel with the puller.	1 set
5.	Mounting tool set	The toolset allows a quick and easy removal and replacement of inner steering ball joint without the need to dismantle steering rack from the bulkhead. Drive head Range Ø 35 to Ø 39 mm	1 set
6.	Alignment tool set	As per available vehicle service manual specifications	1 set

X Precautions to be Followed

1. Avoid improper handling of hand tools and special tools
2. While operating under the vehicle, ensure use of Personal Protective equipment.
3. On most vehicles, the O-ring in the lower pressure hydraulic line fitting is larger than the O-ring in the high pressure line. Make sure the O-rings are installed in the proper fittings. Observe the torque specification given for the hydraulic line fittings. Over-tightening will cause damage to the fitting threads and O-rings.

XI Procedure

Dismantling

1. Raise and support the vehicle safely (support the car on jackstands), then remove the wheels.
2. Disconnect the hose clamp and hose at the steering gear. Disconnect the flare nut and the tube at the steering gear, and then drain the fluid from the gear.
3. Using the Ball Joint Remover tool, remove the tie rod from the knuckle.
4. Place a floor jack under the transaxle and support it.
5. Remove the exhaust tube and the rear engine mount.
6. Remove the steering column lower joint.
7. Unbolt and remove the steering gear unit and the linkage.

Inspection:

If power steering fluid is found under the bellows, check the gear for significant leaks.

a. Wipe the rack shafts on both sides until clean.
b. Start the vehicle, and allow the engine to idle until the power steering fluid reaches an operating temperature of at least 93 °C.
c. Turn the wheels back and forth to the stops three times each way.
d. Center the wheels and shut down the engine.
e. Pull the large ends of the bellows outboard as far as possible and inspect for leaking power steering fluid around the rack. If fluid leaked during the turn test, replace the gear

Assembling

8. Install the power steering gear assembly to the vehicle. Torque the tie rod-to-steering knuckle nut to 35-49 Nm, the steering gear-to-frame clamp bolts to58-79 Nm, the lower joint-to-pinion gear bolt to 29-39 Nm, the lower joint-to-steering column bolt to 29-39 Nm, the low pressure hose clip bolt to 1.02-1.92 Nm and the high pressure hose-to-gear to 15-25 Nm.
9. Refill the power steering pump, start the engine and bleed the power steering system and check the wheel alignment.
   When installing the lower steering joint to the steering gear, make sure that the wheels are aligned with the vehicle and the steering joint slot is aligned with the steering gear cap or spacer mark.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
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XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations

Sr No	Parameter observed	Procedure	Observation
1	Visual Inspection	**1.** Check and correct fluid levels **2.** Check belt tension **3.** Check electrical connections	
2	Power steering fluid level	**4.** Should be checked hot **5.** With engine idling: turn wheel several times in each direction **6.** Before shutting off engine: check fluid level	
3	Steering wheel free play	**7.** Check with the engine off	
4	Diagnosis using scan tool	**8.** Electrical defect: diagnostic trouble code will be displayed	

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. Describe power steering gear service procedure.
2. Describe the procedure to check the steering wheel free play.

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=crqxmJ4YkQ8 Power steering gear service
2. https://www.youtube.com/watch?v=oo-TgERkDvE Power steering gear service

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of tools and special tools	20%
2	Observations	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……..

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 11 : Dismantle, inspect and reassemble the Leaf Spring Assembly.

I Practical Significance

Leaf springs are likely to wear because they have several moving parts. They should be cleaned and inspected at intervals specified by the car manufacturer, or at major service intervals - usually every 20,000 km.

Break-down maintenance / Failure of leaf spring during a journey/ trip can cause substantial financial loss to a transport organization. It causes a lot of inconvenience to the vehicle users as well.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basicEngineeringto solve the broad-based Mechanical Engineering problems.

PO 2-**Discipline knowledge:** Apply mechanical engineering knowledge to solve broad- basedmechanicalengineering related problems

PO3 - **Experiments and practice:**Plan to perform experiments and practices to usethe results to solve broad-based Mechanical Engineering problems.

PO4 -Discipline knowledge: Apply mechanical engineering knowledge to solve broad-engineering related problems

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.
2. Inspect given component/ assembly of the given vehicle
3. Maintain given automobile component/ assembly.

IV Relevant Course Outcome(s)

- Select suspension system for different applications.

V Practical Outcome

- Dismantle, inspect and reassemble the Leaf Spring assembly.

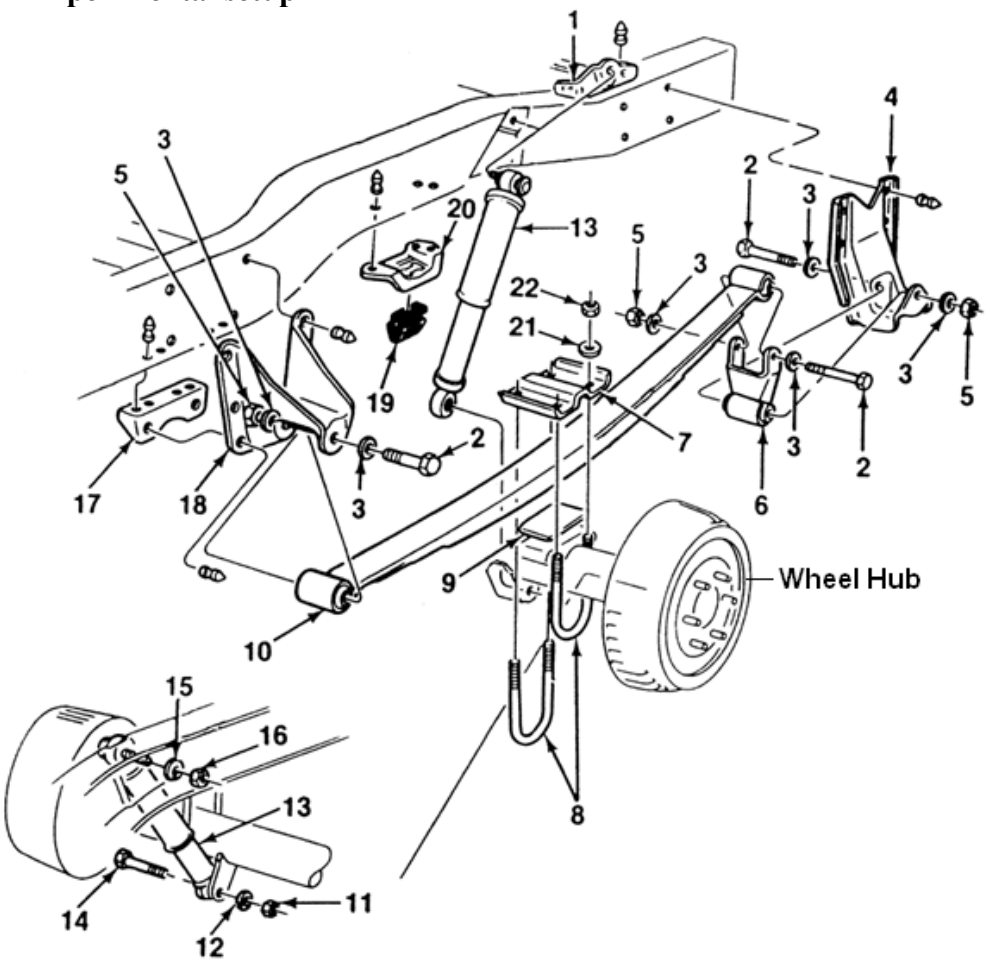
VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools, equipment and service records.

VII Minimum Theoretical Background

The standard leaf spring is made from several thin strips of sprung steel of different lengths and held together by clamps. It is subject to wear as the leaves rub against each other during suspension movement. To overcome this, a tapered-profile single leaf spring is fitted on some vehicles. Leaf springs are an integral part of the vehicle's suspension system. They are installed to help support the entire weight of the car or truck. Leaf springs also help maintain the tyre's grip on the road and regulate the wheelbase lengths when it is speeding up or slowing down.

VIII Experimental setup



1. Bracket
2. Bolt
3. Washer
4. Rear Hanger
5. Nut
6. Rear Shackle
7. Anchor Plate
8. U-bolt
9. Shim
10. Leaf Spring
11. Nut
12. Spring Lock Washer
13. Rear Shock Absorber
14. Bolt
15. Spring Lock Washer
16. Nut
17. Front Hanger Support
18. Front Hanger
19. Axle Bumper
20. Bumper Bracket
21. Washer
22. Nut
23. Bracket
24. Cushion
25. Rear Hanger Reinforcement
26. Leaf Spring Eye Bushing
27. Bolt
28. Nut
29. Nut
30. Bolt
31. Spacer
32. Optional Rear Auxiliary Spring
33. Bolt
34. Washer
35. Nut
36. Stabilizer Bar Anchor
37. Spacer
38. Bolt
39. Spring Clip

Figure 11.1: Exploded view of leaf Spring Suspension system

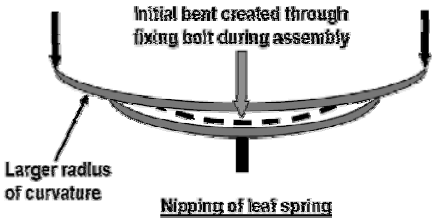


Figure 11.2: Nipping of Leaf Spring

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Vehicle	Vehicle with leaf spring suspension	01
2.	Jack Stand	As applicable for given class of vehicle	2 set
3.	Personal Protective Equipment	safety glasses or goggles: Standard Gloves, Apron …	Adequate as per batch size
4.	Hand tools	Set of standard hand tools	2 sets
5.	Consumables	Lubricant: Silicone lubricant absorbent rags Scrubbing brushes	Adequate

X Precautions to be Followed

1. Always wear proper eye protection and other required personal protective equipment (PPE) when performing vehicle maintenance, service or repairs. Follow applicable safety regulations and shop safety rules.
2. Loose or over torqued fasteners can cause component damage, adverse vehicle handling, property damage, or severe personal injury. Maintain correct torque value at all times. Check torque values on a regular basis as specified.
3. Solvent cleaners can be flammable, poisonous and cause burns. To help avoid serious personal injury, carefully follow the manufacturer's product literature and the following procedures.

- Wear proper eye protection
- Wear clothing that protects your skin
- Work in a well-ventilated area
- Do not use gasoline or other flammable cleaning solvents to clean the suspension, axle, wheel end or brake components. These solvents can explode, burn or disperse harmful vapours.

XI Procedure

Before you jack the car up, put it on level ground, and make sure that the tyres are at their normal pressures and that the car is at its normal 'kerb weight' without passengers, and with a full fuel tank.

Crouch down a little distance behind the car and see how it sits on the road.

It should appear level from side to side. If one side appears lower than the other, there may be a weak or damaged spring on that side.

Prolonged use of the car with only the driver on board may cause a slight sag in the springs on that side of the vehicle. If the sag is significant, the springs may need to be replaced.

Dismantling

1. Support the rear axle with jackstands, support the axle and the body separately in order
   to relieve the load on the rear spring.
2. Remove or disconnect the following:
   Wheel
   Shock Absorber
   U-bolt nuts, washers, anchor plate and bolts
   Spare tyre, if equipped
   Rear exhaust hangers and lower the rear exhaust, if necessary.
   Shackle- to-frame bolt, washers and nut
   Fuel tank, if necessary
   Front bracket nut, washers and bolt
   Spring
   Shackle from the spring, if necessary

Cleaning Leaf Spring:

Dirt particles between separate leaves increase wear and rust. The springs should be kept fairly clean in order to extend their useful life. Refer Service manual for cleaning interval.

Modern leaf springs do not need lubricating with oil — which may damage any anti-friction material between leaves. Spray them instead with a silicone-based lubricant.

Raise the end of the car to clean them. Remove the hub caps and trims from the wheels, and loosen the wheel nuts. Jack up one side of the car so that the wheel is clear off the ground, and support the car on an axle stand under a chassis member and not under the axle.

Repeat the same at the other side of the vehicle, so that it is supported under the chassis on both sides, with the wheels clear off the ground.

Wire-brush as much dirt and rust as possible off the spring, especially between the open ends of the leaves.

Chock the front wheels and remove both rear wheels. If the spring leaves are really caked with dirt and grease, cleaning them is a messy job.

Clean shackles and bushes thoroughly with a wire brush. A lot of housekeeping is needed along with covering the floor and clearing dirt after the cleaning job.Use a proprietary degreasing fluid if necessary, applied with a brush or spray to help remove as much dirt as possible using an old scrubbing brush. Dry the springs afterwards with absorbent rags.

Wear safety glasses or goggles to prevent small particles of grit or rust being flicked into your eyes.

Inspection:

3. Look to see if one spring is flatter than the other. If yes, check the ride height

Examine the edges of the spring leaves, look for cracks. If yes, replace.
Look at the lower surfaces of the leaves, where the ends of the shorter leaves bear against those above. If the depression exceeds 3 mm, replace it.
Check the condition of the shackle pins that pass through the rubber bushes. Replace if faulty.
If U-clamps need tightening, check leaves to see if they have moved sideways. If they have, tap them back with a soft-faced hammer.
Make sure the nuts on the U-bolts which hold the springs to the axle are tight. If they are loose, the axle will move in relation to the springs. That will causesteering and tyre wear problems. It will also cause the brakes to judder on application.
If the bushes are damaged, they must be replaced.
After cleaning and inspecting the springs, lubricate them lightly with silicone lubricant, replace both wheels and their wheel nuts. Lower the car to the ground and fully tighten the wheel nuts.Replace the hub caps and trims, making sure that they are securely located.

Assembling

4. Install or connect the following:
Shackle to the rearward spring eye using the bolt, washers and nut, but do not fully tighten at this time.
Spring Assembly
Spring to the front bracket using the bolt, washers and nut, but do not fully tighten at this time.
Fuel tank, if removed
Shackle-to-frame bolt, washers and nut, but do not fully tighten at this time. If used, remove the spring support.
U-bolts, anchor plate, washers and U-bolt nuts. Torque the nuts using 2 passes of a diagonal sequence:

A. Step 1: Torque to 25 Nm.
B. Step 2: Torque to 100 Nm in the sequence.

5. Position the axle to achieve an approximate gap of 6.46-6.94 in. (164-176mm) between the axle housing tube and the metal surface of the rubber frame bumper bracket. Measure from the housing between the U-bolts to the metal part of the rubber bump stop on the frame.

6. While supporting the axle in this position, tighten the front and rear spring mounting fasteners to 89 ft. lbs. (122 Nm).

7. Install or connect the following:

Rear exhaust in position and tighten the hangers
Spare tyre
Shock absorber

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations

Sr No	Parameter	Observation	Remarks
1	Is any one of the leaves flatter than others?	No	Acceptable and may be assembled
		Yes	Vehicle will have tilt to one side. Check the ride height. Examine the edges of the spring leaves, look for cracks. Fractures found in the spring leaves cannot be repaired by welding. The leaf or the complete spring must be replaced as soon as possible.
2	Look at the lower surfaces of the leaves,	The leaves appear to bind as they move against each other.	The tips of the shorter leaf may dip into the surface of the leaf above it, and make a slight depression. A slight depression is acceptable, but the spring should be replaced if the depression exceeds 3 mm.
3	Are the U-bolts slack?	No	
		Yes	

4	Inspect each bush for signs of wear or distortion		

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. Describe concept of 'Nipping in leaf spring'.
2. Describe the leaf spring lubrication process.
3. Describe the inspection procedure for leaf spring assembly.

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=VJzk30s2r0U replacing a single broken leaf spring on the vehicle
2. https://www.youtube.com/watch?v=7vucGOb3HLk Restoring old leaf springs
3. https://www.howacarworks.com/suspension/cleaning-and-checking-leaf-springs

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of tools and special tools	20%
2	Observations	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 12 : Remove, inspect and refit the Wheel And Tyre Assembly.

I Practical Significance

Tyres need to respond accurately to steering commands, they need to roll smoothly and cope with the stresses that come from braking, cornering and accelerating. Above all tyres need to keep vehicles safely and securely on the operating surface in different conditions including when dry, wet and slippery or covered in snow and ice.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipment for dismantling and assembly of various automobile system components.
2. Inspect given component/ assembly of the given vehicle.
3. Maintain given automobile component/ assembly.

IV Relevant Course Outcome(s)

- Select suspension system for different applications.

V Practical Outcome

- Remove, inspect and refit the Wheel and Tyre assembly

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Maintain tools, equipment and service records.
- Follow ethical Practices.

VII Minimum Theoretical Background

TYRE PRESSURE

It is important to keep the right amount of air pressure in your tyres (including your spare). Correct pressure helps to ensure optimum braking performance and minimization of wear. Correct pressures also optimize comfort, handling and fuel economy.

WHEEL NUTS

Wheel nuts must be checked regularly to ensure they are tightened to the correct torque. Improperly torque nuts or bolts can result in wheel assemblies coming off, brake damage, broken and or stripped nuts, bolts and studs. There are many different wheel-nut indicator systems available that identify when a nut is loose or damaged. Torque settings should be as per the manufacturer's guidelines.

VIII Experimental setup

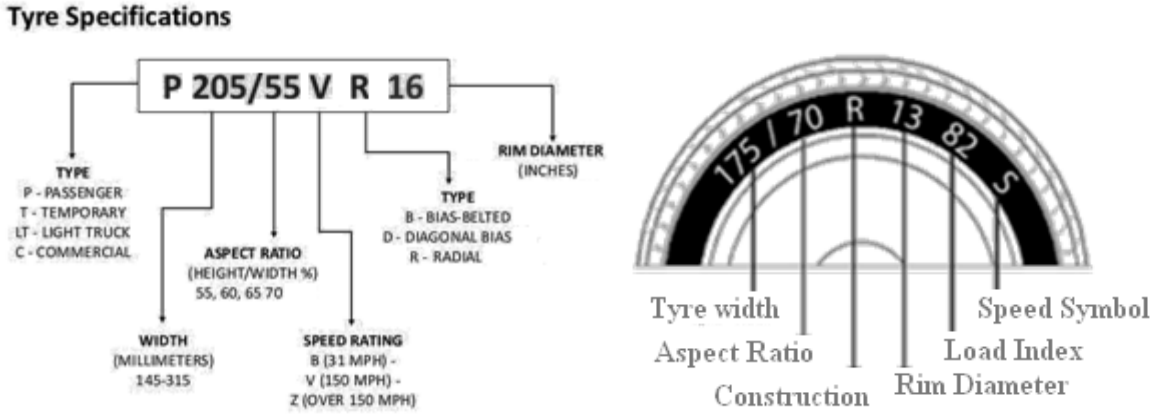
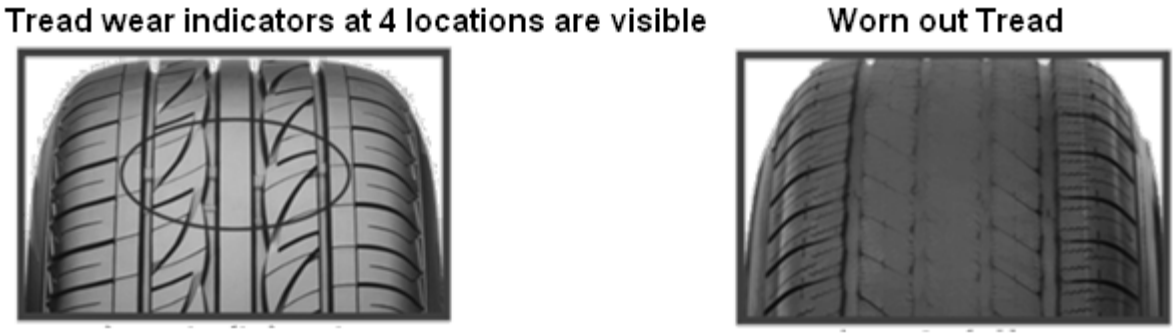


Figure No 12.1: Tyre specification



(a) **(b)**

Figure No 12.2: Tread Wear Indicator- (a) Treads are Intact, (b) Treads are worn out

Figure No 12.3:Damaged Wheel rim: a result of rim hitting a pothole and also causes a blown tyre. Replacement of tyreand wheel balancing is not sufficient as a slight shimmy is experienced by the driver and vehicle occupants.

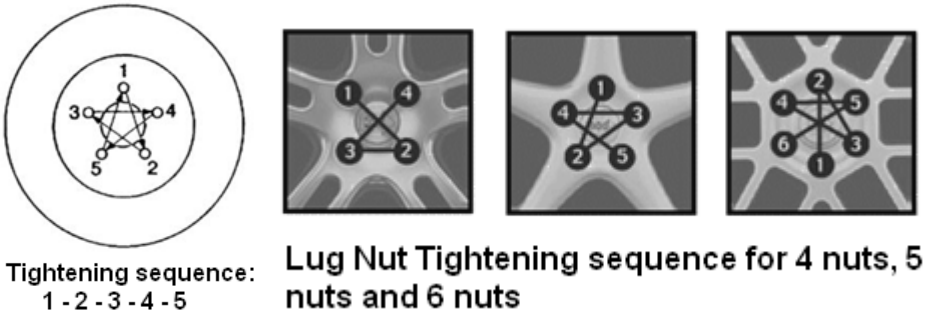


Figure No 12.4:Star Lug Nut Tightening Sequence

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Hydraulic jack	As per vehicle service manual specification	02
2.	Jack stand	Standard / as per vehicle service manual specification	04
3.	Tyre tread depth gauge	Calibrated up to 25 mm (1 inch)	01
4.	Tyre pressure gauge	0 to 10 bar (*0 to 150 PSI*)	01
5.	Lug nut socket and wrenches	4 way Lug nut socket and wrench, torque limit sockets, impact sockets	01
6.	Tyre mounting and demounting tools	Tyre mounting and demounting tools set	1 set
7.	Wheel service tools	Wheel lifting bar, tyre mounting and demounting spoon, swan neck leverage bar and bead breaker as per vehicle service manual specification	1 set
8.	Wheel and Tyre assembly	Wheel and tyre assembly of car / LCV / HCV	04
9.	Air compressor	As per service manual specification for relevant vehicle wheel and tyre assembly.	01

X Precautions to be Followed

1. Do not place hands or wrists under wheel well while vehicle is suspended.
2. Do not service split rim-type tyres unless specifically trained in their repair and hazards.
3. Do not mount damaged tyres or wheels.
4. Do not hammer on rims or components with a steel hammer to correct seating of flanges and to lock ring. Use rubber, lead, plastic or brass-faced mallets and make sure the tyre is uninflated.
5. Do not weld on an inflated tyre rim. Carry out welding repairs to rims with the tyre removed from the rim and only if specially trained for such work.
6. Do not inflate a tyre that is in poor condition as a blowout could occur.
7. Do not attempt to repair tyres larger than your equipment can handle.
8. Never use oil or grease on studs and nuts.

XI Procedure

Dismantling

1. If equipped, remove the hub cap/wheel cover. Many vehicles use styled wheels with covers over the wheel retaining nuts (also called lug nuts). Some vehicles may use bright-finished metal caps, others may use a black plastic cap. Use a deep socket to unscrew these covers.
2. With the vehicle still on the ground, use a deep socket and a suitable breaker bar or ratchet to break loose, but do not remove the lug nuts. Loosen wheel nuts before lifting vehicle off the ground.
3. Raise vehicle only a few centimeters (one inch) from the floor when doing operations on a freewheel or frame-contact lift. Block a vehicle securely on a lift to prevent rolling.
4. Remove or replace the wheel from a squatting position. Minimize back strain by not bending forward.
5. Raise and safely support the vehicle. Always use a suitable floor jack for raising the vehicle to be serviced. Never use the jacking device supplied with the vehicle for vehicle service. That jacking device is designed for emergency use only to change a flat tyre.
6. Remove the wheel lug nuts. Since the tire and wheel assemblies were originally balanced as an assembly on the vehicle and since many professional tire shops may spin balance a tire and wheel assembly while mounted on the vehicle (so the brake rotor and hub are also included in the balance computation), a tire and wheel assembly should always be installed in the same location as removed. **Mark the location of the tyre and wheel to the hub**. Many technicians will **chalk the end of the topmost wheel stud and place another chalk mark on the corresponding wheel opening**. In this way, the tire and wheel assembly can be installed in the same relationship as when removed.
7. Remove the tire and wheel assembly.

Inspection

8. Tyres are used on a wide variety of vehicles and their condition is often overlooked. Tyre condition is a crucial safety component for any vehicle. Tyres are the only contact vehicle has with the surface it is operating on and are one of the most important safety features of any vehicle.
9. Regular inspections can help you prevent tyre trouble, and keep vehicle rolling safely down the road. The tread on vehicle tyre should be at least 2 mm deep. If it isn't, the tyre must be replaced. To help one see tread problems, tyres have built-in “tread wear indicators.”
10. Tyres should be inspected regularly as part of a proactive maintenance practice. Tyres and wheels must be part of any daily pre-start checklist.

    Caution

    Before installing a wheel, remove any build-up of corrosion on the wheel mounting surface or rotor, by scraping and wire brushing. Installing wheels

without good metal-to-metal contact at mounting surfaces can cause wheel nuts to loosen, which may later allow the wheel to come off while the vehicle is in motion.

Assembling

11. Clean the wheel nuts, studs and the wheel and rotor mounting surfaces.
12. Refer to vehicle's owner manual for any special instructions or precautions.
13. Make sure all rim components are properly in place and secured before inflating.
14. Mount the tyre fully before inflating.
15. Support tyre securely with lifting equipment before attempting to attach the tyre to the hub.
16. Install the tyre and wheel assembly aligning the locating marks made at removal.
17. Never use oil or grease on studs and nuts. Tighten the wheel nuts with your fingers until they are snug. Then tighten the nuts in a "star" pattern.
18. Lower the vehicle. With the vehicle on the ground, recheck the wheel lug nut torque. One should not perform a final tightening of the lug nuts while vehicle is in the air, hopefully, supported safely by jack stands. Tighten the wheel bolts (lugs) snugly before you lower the vehicle back to the ground, but always be sure to perform a proper lug tightening when the car is sitting firmly on the ground, all four wheels. You'll get a much firmer platform to perform your tightening when the car is on the ground, but it's a lot safer to be pushing on a big wrench if the car is not on jack stands.
19. Use of a torque wrench is important. Follow vehicle service manual for the wheel nut torque specification of the vehicle. Improperly tightened wheel nuts could eventually allow the wheel to come off while the vehicle is moving, possibly causing loss of control, personal injury and property damage.
20. Aluminum wheels will distort under uneven wheel lug nut pressure. Unequal torque can also distort brake rotors, causing uneven brake wear and pulsations in the brake pedal.
21. Install the hub cap, if equipped. Install the lug nut cosmetic covers, if equipped.
22. Check tyre pressure to prevent over-inflation or under-inflation with a tyre pressure gauge.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

6.					
7.					
8.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations and Calculations

Sr. No	Parameter	Observation	Remark
1	Wheel rim		
2	Wheel nut		
3	Tyre beads		
4	Tyre tread		
5	Tyre sidewall		
6			

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. List six dos and don'ts for wheels and tyres.
2. Describe inspection procedure for wheels and tyres.
3. State tightening torque for a car wheel lug/ nut by referring service manual.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=VbN9Y_fUvjo How to tighten the wheel nuts
2. https://www.youtube.com/watch?v=lPm6sCCyFqE Simple Tyre inspection Part 1
3. https://www.youtube.com/watch?v=cYReHcmwVhc Simple Tyre inspection Part 2
4. https://www.youtube.com/watch?v=Vzcc-9DXRN4 How to check for a bent wheel
5. https://www.youtube.com/watch?v=LXj1B8dTpGI How to torque lug nuts with torque wrench

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the tools and equipments	20%
2	Observations	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 13 : Test a lead acid battery for Open Voltage and Specific Gravity

I Practical Significance

Battery testing is an important part of electrical system service. It helps a technician to understand the state of charge of battery, and the also the energy that can be stored in battery. Battery testing enables us to decide if the battery can be put into use in vehicle or not. Battery tests help us to locate weak cells and faults in battery. Visual inspection is important aspect of battery testing. Slow engine cranking and dim headlights are some of the signs that indicate a weak or discharged battery. Lack of maintenance leads to premature failure of battery. Testing avoids premature failure of battery.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Inspect given component/ assembly of the given vehicle
2. Test given battery of an automobile.

IV Relevant Course Outcome(s)

- Prepare simple electrical-electronic circuits for automobile systems.

V Practical Outcome

- Test a Lead Acid Battery for Open Voltage and Specific Gravity

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Maintain tools, equipment and service records.

VII Minimum Theoretical Background

Depending on the construction of the battery, state of charge of battery can be determined in the following ways:

1. Specific gravity test
2. Visual Inspection of battery with a built- in hydrometer and
3. Open circuit voltage test.

1. **Specific Gravity Test:** On unsealed batteries, the specific gravity of the electrolyte in each cell can be measured to give a fairly good indication of the battery's state of charge. A hydrometer consists of a glass tube or barrel, rubber bulb, rubber tube, and a glass float or hydrometer with a scale built into its upper stem. The glass tube encases the float and forms a reservoir for the test electrolyte. Squeezing the bulb pulls electrolyte into the reservoir.
   When filled with test electrolyte, the sealed hydrometer float bobs in the electrolyte. The depth to which the glass float sinks in the test electrolyte indicates its relative weight compared to water. The reading is taken off the scale by sighting along the level of the electrolyte.
   The electrolyte of a fully charged battery is usually about 64 % water and 36 % sulfuric acid, which corresponds to a specific gravity of 1.270. Specific gravity is the weight of an equal volume of water. Pure water has a specific gravity of 1.000, while battery electrolyte should have a specific gravity of 1.260 to 1.280 at 26.7ºC. In other words, the electrolyte should be 1.260 to 1.280 times heavier than water.
   The specific gravity of the electrolyte decreases as the battery discharges. This is why measuring the specific gravity of the electrolyte with a hydrometer can be a good indicator of how much charge a battery has lost.

2. **Visual Inspection of battery with a built- in hydrometer:** If the battery has a built-in hydrometer, observe the indicator colour. A green indicator means the battery is over 65% charged. If the hydrometer indicator is dark, the battery is less than 65 % charged. Under this condition, the battery should be charged and load tested. A clear hydrometer indicator means the battery is low on electrolyte. If this condition is present on a battery with removable filler caps, add distilled water to the cell(s) as required. When a clear hydrometer is present in a maintenance-free battery, replace the battery.

3. **Open Circuit Voltage Test:** An open circuit voltage check can be used as a substitute for the hydrometer specific gravity test. As the battery is charged or discharged, slight changes occur in the battery's voltage. So battery voltage with no load applied can give some indication of the state of charge.

VIII Experimental setup

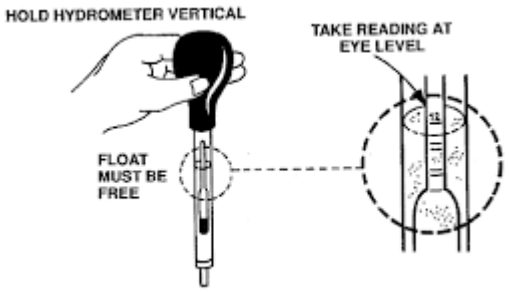

Figure No 13.1: Specific Gravity Test: Indicates state of charge of battery. Specific Gravity Test is performed on battery with removable filler caps

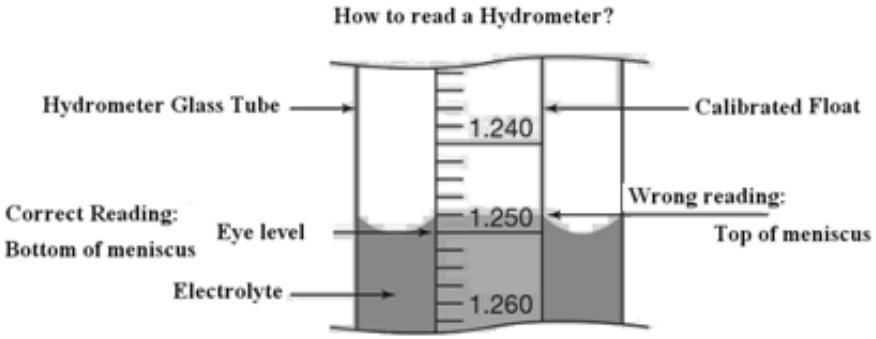

Figure No. 13.2: Hydrometer, Calibrated Float and Reading

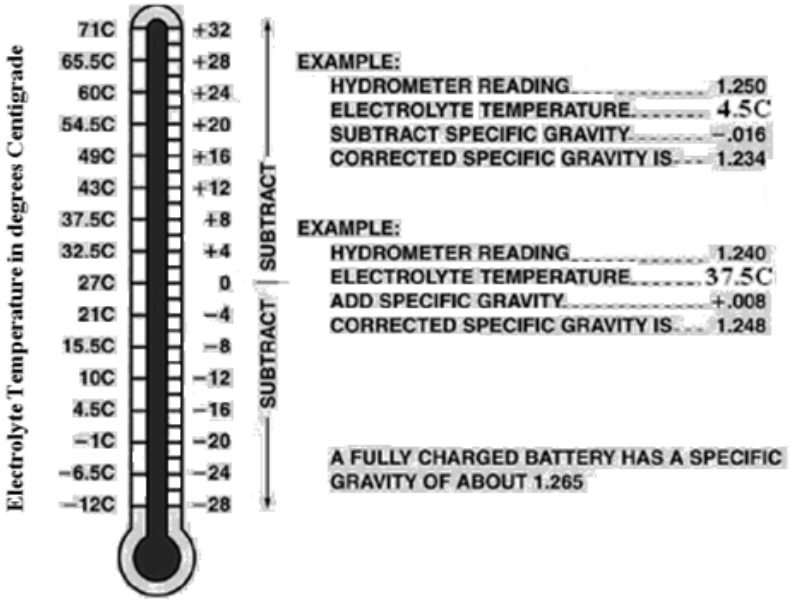

Figure No 13.3:Specific Gravity reading is corrected if the temperature is above or below certain temperature (Approx. 27ºC or as specified by battery manufacturer)

Table-1 : Electrolyte specific gravity as related to charge	
Specific Gravity	Percentage of Charge
1.265	100 %
1.225	75 %
1.190	50 %
1.155	25 %
1.120 or lower	Discharged

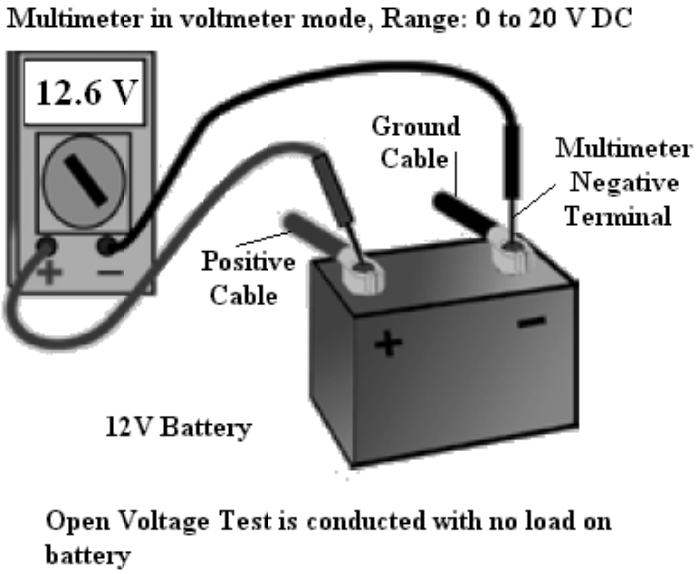

Figure No. 13.4 Open Voltage Test of Battery

Table-2 : Battery open circuit voltage as an indicator of state of charge of battery	
Open circuit voltage	State of charge of battery
12.6 or greater	100%
12.4 to 12.6 V	75- 100 %
12.2 to 12.4 V	50-75 %
12.0 to 12.2 V	25 – 50 %
11.7 to 12.0 V	0 – 25 %
11.7 V or less	0 %

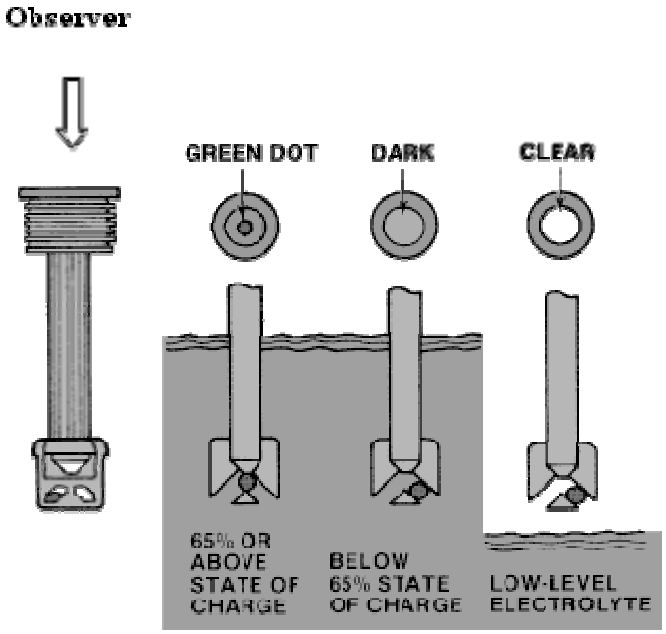

Figure No 13.5: Visual Inspection of Sealed maintenance free battery:
A Temperature compensated In-built Hydrometer is built into the battery cover

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Lead Acid Battery	100 AH battery or a suitable battery of a car	02
2.	Hydrometer	Standard, Specific gravity measurement value 1.100 to 1.300, float with colour zones	02
3.	Digital Multi-meter	Voltage: DC: 600 volts; AC: 600 volts; DC Accuracy: ± 0.5% + 3 digit; AC Accuracy: ± 1% + 3 digit Resistance: 40 M ohm; Resistance Accuracy: ± 1.5% + 3 digit Capacitance: 100 μF AC/DC voltage, resistance, capacitance, frequency measurement	02
4.	Battery Charger	Vehicle Compatibility: Passenger cars, Automatic detection of battery types whether 12V or 24V, Regulative function for deeply discharged batteries, Trickle charging for optimum battery care, Allows supportive charging and supplies mobile devices with power, Dust and splash water proof.	01

X Precautions to be Followed

1. **During Specific Gravity Test**, following precautions should be taken: Wear suitable eye protection goggle. Use hand gloves to protect from sulfuric acid. The hydrometer should be washed with clean water after use and stored safely.
2. **During Open Voltage test**, following precautions should be taken. The battery's temperature should be between 15.5ºC and 37.7º C. The voltage must be allowed to stabilize for at least 10 minutes with no load applied. On vehicles with high drain (computer controls, clock, and accessories that always draw a small amount of current), it may be necessary to disconnect the battery ground cable. On batteries that have just been recharged, apply a heavy load for 15 seconds to remove the surface charge. Then allow the battery to stabilize. Once the voltage has stabilized, use a voltmeter to measure the battery voltage to the nearest one-tenth of a volt. Be sure to remove the surface charge completely.

XI Procedure

- **Specific Gravity Test procedure:**

➢ Remove covers or vent caps from battery cells.
➢ Squeeze the suction rubber bulb and insert the pickup tube into the cell closest to the battery's positive terminal.
➢ Slowly release the bulb to draw in only enough sample of electrolyte to cause the float to rise.

- Do not remove the tube from the cell. Read the specific gravity indicated on the float. Be sure the float rises freely.
- Note down the readings and repeat the steps for remaining cells.
  Table-1 lists specific gravity reading in various stages of charge with respect to a battery's ability to crank an engine at a temperature of 26.7ºC.

- **Open Circuit Voltage Test Procedure:**

- Remove the surface charge from battery, if any. Refer precautions section for the steps to remove surface charge. If vehicle is not available, certain load may be applied to remove the surface charge.
- Connect the digital voltmeter across the battery terminals.
- Note down the voltmeter reading of a 12-V battery.
  Use the following table-2 to interpret the results. Minor changes in the battery open circuit voltage can indicate major changes in the state of charge.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations Table

Specific Gravity Test

Sr. No.	Cell No.	Cell Specific Gravity	Percentage Charge
1	1		
2	2		
3	3		
4	4		
5	5		
6	6		

Open Circuit Voltage Test

Sr. No.	Voltmeter Reading in Volts	State of Charge of Battery

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the significance of Open Voltage test and specific gravity test.
2. Enlist the precautions while handling hydrometer. State the effect of temperature on the specific gravity reading.
3. List precaution to be taken before conducting Open circuit voltage test on battery.
4. List precaution should be taken before conducting Specific Gravity test.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=jn12gsvfAlI Open voltage test of battery
2. https://www.youtube.com/watch?v=tUDw1TYU2u8 Specific gravity test of battery

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Handling of the battery and relevant instruments	20%
2	Observations	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 14 : Dismantle, inspect and reassemble the Distributor used in Battery Ignition System.

I Practical Significance

Rough running, increased fuel consumption, an illuminated dashboard Engine Check light or even a non-starting engine can be caused by a neglected ignition system.

A worn-out or improperly set distributor can render a vehicle inoperable, and there are several ways you can tell if your distributor that needs replacing. Therefore it is essential to maintain distributor used in ignition system.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3 - **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Inspect given component/ assembly of the given vehicle

IV Relevant Course Outcome(s)

- Prepare simple electrical-electronic circuits for automobile systems.

V Practical Outcome

- Dismantle, inspect and reassemble the Distributor used in Battery Ignition System.

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Maintain tools, equipment and service records.

VII Minimum Theoretical Background

Modern S.I. engines use electronic ignition system. The distributor provides high voltage pulses to spark plugs in engine cylinders as per firing order. Most commonly used firing order for four cylinder engine is 1-3-4-2.Most electronic ignition distributors use a pickup coil to sense trigger wheel position and rotational speed. The pickup coil sends small electrical pulses to the ECU. If the distributor fails to produce these electrical pulses properly, the ignition system can stop functioning. A faulty pickup coil will produce a wide range of engine troubles, such as stalling, loss of

power, or not starting at all. If the small windings in the pickup coil break, they will cause problems only under certain conditions. It is important to know how to test a pickup coil for proper operation.

Ignition Timing: In conventional distributor, the ignition system must be timed so the sparks jump across the spark plug gaps at exactly the right time. Adjusting the distributor on the engine so that the spark occurs at this correct time is called setting the ignition timing. The ignition timing is normally set at idle or a speed specified by the engine manufacturer. Before measuring engine timing, disconnect and plug the vacuum advance hose going to the distributor. This action prevents the vacuum advance from functioning and upsetting the readings. Adjustment is made by loosening the distributor hold-down screw and turning the distributor housing within its mounting, and then tightening the same.

Turning the distributor housing against the distributor shaft rotation advances the ignition timing. Turning the distributor housing with shaft rotation retards the ignition timing.

VIII Experimental setup

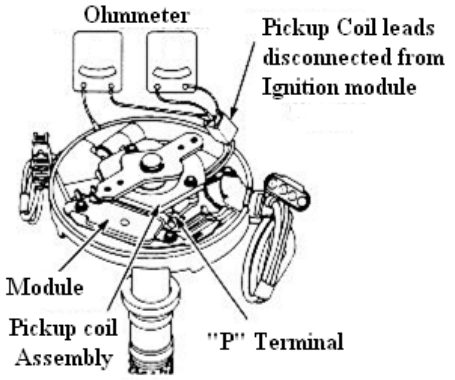

Figure 14.1: Pickup Coil Testing using an Ohmmeter

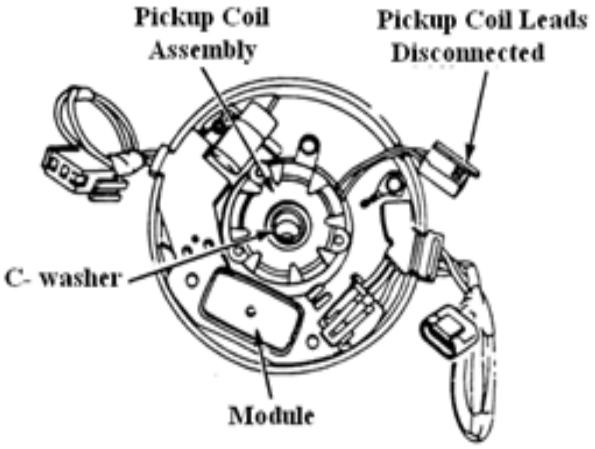

Figure 14.2: Electronic Ignition system Distributor components

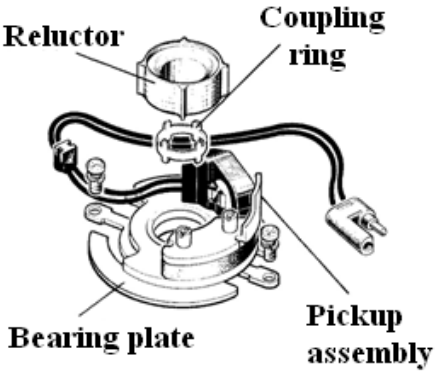

Figure 14.3: Distributor backplate with reluctor and pickup assembly exploded view

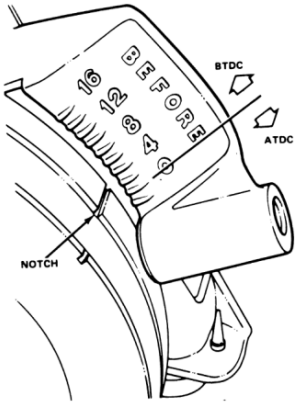

Figure 14.4 Ignition Timing mark at engine front end.

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Ignition distributor of electronic ignition system	Distributor with inductive pick up coil	02
2.	Digital Multi-meter	Voltage: DC: 600 volts; AC: 600 volts; DC Accuracy: ± 0.5% + 3 digit; AC Accuracy: ± 1% + 3 digit Resistance: 40 M ohm; Resistance Accuracy: ± 1.5% + 3 digit Capacitance: 100 µF AC/DC voltage, resistance, capacitance, frequency measurement	02
3.	Ignition Timing Gun	Suitable for Conventional, electronic and Computerized Ignition systems, Inductive pick-up, flashlight feature button, zenon or neon flashlight	01
4.	Plastic feeler gauge	0.05-1mm Thickness Plastic Feeler Gauge Gap Feeler Measuring Tool.	02

X Precautions to be Followed

1. If you decide to check out a modern battery ignition system, you should know note that extremely high voltages are employed. Never touch any part of the circuitry either when the ignition is switched on or the engine is running.
2. Keep your hands and the timing light leads from the engine fan and belts. The spinning fan and belts can damage the light or cause serious personal injury.

XI Procedure

Dismantling

1. Locate the distributor. Park the vehicle in a safe, secure place (like a garage or a level stretch of ground) and open the hood to access the engine compartment. Look for the distributor - often, this is a cylindrical part with thick wires coming out of it that sits near the engine.
2. The distributor has a Bakelite cap with spark plug wires coming out of it. There will be one wire for each cylinder of the engine. There will also be one additional wire connected to the ignition coil.
3. Find the timing specifications for your vehicle. Replacing the distributor requires you to use a timing light to set/adjust the timing of the engine after the original/new distributor is installed. To do this, you'll need to use the timing specifications unique to your vehicle. Often, these are on a sticker under the hood or in the engine compartment. You may also be able to find these in your vehicle's manual.
4. If you don't have the timing specifications for your vehicle, don't attempt to service /install a new distributor. In this case, it's much safer and easier to simply bring your vehicle to an authorized service station for relevant vehicle.
5. Disconnect the distributor cap. As noted above, most distributors have a Bakelite cap from which the High tension wires emerge. To begin removing the distributor, remove the cap. This may or may not require basic tools - some caps have clamps that can be loosened by hand, while others may require screwdrivers or even socket wrenches to unscrew screws and/or bolts holding the cap in place.
6. Remove all wires attached to the distributor. Before disconnecting each wire, mark it so that you'll be able to reconnect it in the same place in the assembled /new distributor. Electrical tape works well for this purpose - use the tape to give each wire a "tag" and, if you'd like, make notes on the tag with a marker. Match-mark the distributor housing and the rotor.
7. As and when working with any sort of electrical system, never tamper with a vehicle's electrical wires while the vehicle is running or any electrical current is flowing through the relevant components/ assembly.
8. Mark the engine mounting point. To make it a little easier to install the assembled/ new distributor, it's a good idea to mark a location on the outside of the distributor housing where the distributor is mounted to the engine. Choose a spot for which you can find a corresponding location on the assembled /new distributor. This can make it simpler to line up the distributor's housing with the engine mounting point (which you may also want to mark).

Inspection

9. Prior to diagnosis or testing procedures, visually inspect the components of the ignition system. Check for the following.

- Damaged, corroded or loose electrical connections
- Damaged /corroded or worn electrical insulation and ignition wires
- Poor spark plug connection
- Blown fuse/s, excessively worn or damaged distributor cap or rotor

Check the spark plug wires and boots for signs of poor insulation that could cause shorting. Make sure the battery is fully charged and that all accessories are off during diagnosis and testing. Check to make sure that the external and internal surfaces of the cap are clean - if there's erosion on the surface or rust and corrosion on the firing points, it's time to replace your distributor. Also check to make sure that the rotor is in great condition, since this is the point where high-tension sparks move from one distributor cap to another. The rotor should have a secure fit, and it should be checked for traces of carbon, as well as burns. If you notice a slight build-up of carbon inside the distributor, this could short out the coil voltage and ultimately result in a misfire in the spark plugs.

10. After performing the basic checks the following additional checks are done. Pulse Generator Gap. The gap depends on the type of engine but a typical gap is 0.2-0.4 mm. A plastics feeler gauge blade is used during checking of the gap.

11. The pick-up leads from the pulse generator are disconnected at the harness connector and an ohmmeter is used to measure the resistance of the pick-up coil. The resistance value depends on the application (a typical value is 2 – 5 kΩ).You should refer to the service manual for exact specifications. Any change in the readings during the pickup coil resistance test indicates the coil should be replaced. Refer to the manufacturer's service manual for instructions for the removal and replacement of the pickup coil.

Assembling:

12. Assembly is done in reverse order of distributor assembly. Rotor and distributor body are mark matched. Distributor housing and engine are mark matched.

Ignition timing Check: Set the engine crankshaft at Top Dead Center (TDC) of the No. 1 cylinder compression stroke. The electronic ignition system timing is controlled by computer. Ignition timing adjustment is not possible or necessary.

Check the timing. Stop the engine and put timing light on the Cylinder number-1 spark plug. Restart the engine. Check and achieve the specified STATIC ignition timing at idle condition (without centrifugal or vacuum ignition system) by rotating the distributor housing by very small amounts. Be sure to follow the instructions specific to your vehicle.

When you've adjusted your timing to the proper setting, tighten the fasteners you left slightly loose previously.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations

Sr. No.	Parameter	Observed parameter
1	Distributor pulse coil and reluctor gap (in mm) using plastic feeler gauge	
2	Distributor Pulse coil resistance	

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. State the reason for using plastic feeler gauge while checking and adjusting pulse coil and reluctor gap.
2. Describe the procedure to check the ignition pulse coil.
3. Describe the effects of fault ignition system on engine functioning.
4. Describe the procedure to advance / retard static ignition timing of an engine.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=groLt6lg1Ck Electronic Ignition diagnosis
2. https://www.youtube.com/watch?v=wifTHbb06_I setting ignition timing

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Inspection of pick-up coil and measurement of gap between reluctor and pick up coil	20%
2	Ignition timing setting by adjusting distributor housing position	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 15 : Prepare A simple electrical circuit for Automobile applications Like Lighting/Horn/Wiper /Flasher/ Indicators/Gauges Etc.

I Practical Significance

Modern automobiles use advanced technologies. Most of the vehicle control systems are computer controlled. These system modules require complex electrical wiring systems. To work with these systems, one should begin with constructing simple electrical circuits used in automobile applications.

II Relevant Program Outcomes (POs)

PO1 - **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic Engineering to solve the broad-based Mechanical Engineering problems.

PO3 - **Experiments and practice :**Plan to perform experiments and practices to use the results to solve broad-based Mechanical Engineering problems.

III Competency and Skills

One of the main competency that a mechanical engineering student should posses is 'Pe**rform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

- Construct simple electrical circuit for automobile application.

IV Relevant Course Outcome(s)

- Prepare simple electrical-electronic circuits for automobile systems.

V Practical Outcome

- Prepare a simple electrical circuit for Automobile applications like Lighting/Horn/Wiper/Flasher/Indicators/Gauges etc.

VI Relative Affective Domain-

- Follow the road and workshop safety practices.
- Practice good housekeeping.
- Maintain tools, equipment and service records.

VII Minimum Theoretical Background

A circuit uses following components. A power source, a switch, a circuit protection device (fuse and circuit breaker), relevant cable/ wire of appropriate gauge and of colour code, terminals/ connectors and electrical load/ device and finally a ground connection for return path of electrical circuit.

A power source in an automobile is storage battery. Alternator generates electricity and provides the same to battery and other electrical/ electronic components.

Cables used for automobiles are mostly copper strands insulated with PVC. The cable size depends on the current drawn by the electrical load. Larger cable causes smaller

voltage drop in the circuit, but the cable becomes heavier. So, appropriate cable size is selected considering allowable voltage drop and maximum cable size.

Fuse is a deliberately designed weak link in the circuit. If an overload of current occurs then the fuse will melt and disconnect the circuit before any serious damage occurs. Automobile fuses include glass cartridge, ceramic and blade type. Circuit breaker has same function as a fuse with the advantage that it can be reset manually or automatically.

Automobile Electrical system has various loads like starter motor, ignition system, fuel pump, lighting system, instrumentation and auxiliaries like wiper, direction indicators, electrical fan, control modules and battery to be charged.

Switch is a device for making and breaking the path of current flowing through a circuit. It has contacts and mechanical arrangement for moving the contacts. Single pole/ throw and double pole/ throw switches are most commonly used switches.

Relay is an electromagnetic switch that can be used to pass large amount of current to a specific electrical load, without overloading a conventional switch or wiring harness. When the relay is switched on, electrical current from the power source (battery) passes through the relay to operate a switch within the relay. Electric current then flows directly to the accessory, without passing through the entire wiring harness.

VIII Experimental setup

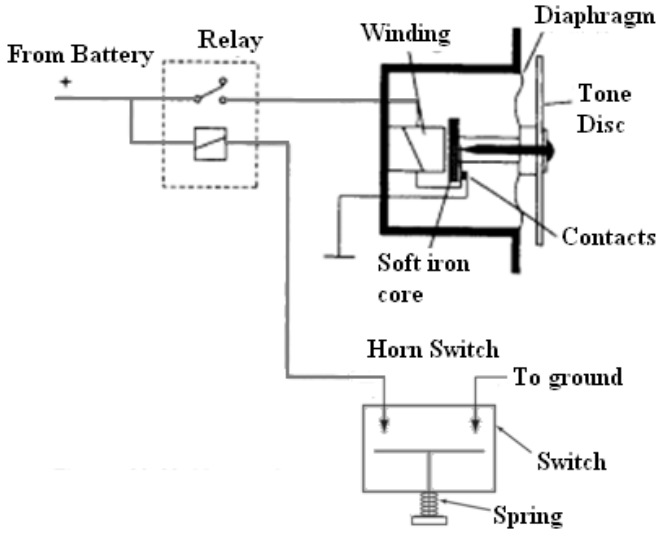

Figure 15.1: Electric Horn and its Circuit

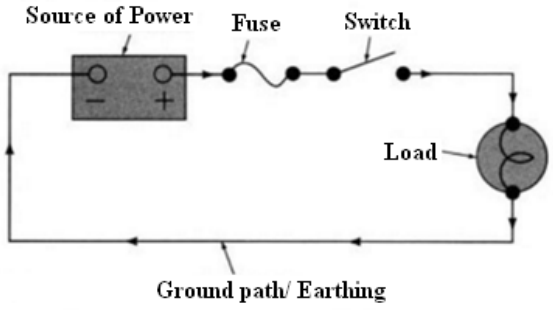

Figure 15.2: Simple Electrical Circuit

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1.	Wooden board	Wooden board of adequate size for construction of simple circuit relevant to an automobile	Adequate as per student strength
2.	Spare part catalogue	Spare parts catalogue of two- wheeler or other vehicle/s	01 each
3.	Service manual	Service manual of two- wheeler or other vehicle/s	01 each
4.	Spares relevant to circuit	Set of components to construct simple circuits	Adequate as per student strength

X Precautions to be Followed

1. Ensure proper electrical connections.
2. Avoid using corroded components and contacts
3. Use standard components as recommended for circuit
4. Handle battery with care. Follow handling instructions printed on the battery case/ displayed in the laboratory.

XI Procedure

1. Refer relevant vehicle service manual circuit diagram for construction of circuit.
2. Use spare part catalogue to obtain relevant components from spare parts dealer.
3. Mount the components on a board.
4. Connect relevant components using relevant components using circuit diagram.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

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XIV Precautions Followed

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XV Observations

	Aggregate used in the circuit	Construction	Function	Category of aggregate: Source of power, Load, Circuit protection and alike
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XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questionsso as to ensure the achievement of identified CO.

1. List the components of Starting circuit of a vehicle. State function of the components.
2. Sketch circuit for wiper.
3. Sketch circuit for stop light of two-wheeler.
4. Sketch and explain working of headlight circuit.

[Space for Answer]

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XX References / Suggestions for Further Reading

1. IS 13313: 1991 Automotive Vehicles – Electrical wiring colour coding
2. https://www.globalbajaj.com/media/21509/v15-c101a_spcatalogue_10012017.pdf spare parts catalogue of a two wheeler

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10 Marks)		**(40%)**
1	Construction of electrical circuit using components	20%
2	Precautions taken while handling and assembling circuit relevant components.	20%
Product Related (15 Marks)		**(60%)**
3	Interpretation of result	20%
4	Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……..
2. …….
3. ……
4. …….

Marks Obtained			Dated signature of Teacher
Process Related(10)	**Product Related(15)**	**Total (25)**	

Practical No. 16 : Maintain given Automobile component using various Service Tools.

I Practical Significance

Various hand tools, measuring devices and power tools are used in automobile workshop in maintenance and repair work. It is important to select right tool for given job and adopt the right method for using these tools following safety practices. In this practical, we make use of various hand tools, power tools and measuring devices that are commonly used in automobile garages and workshops.

II Relevant Program Outcomes (POs)

1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Automobile engineering problems.
2. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Automobile engineering problems.
3. **Engineering tools:** Apply relevant Automobile technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

One of the main competency that a mechanical engineering student should posses is 'P**erform the job of Mechanical supervisor in Automobile Industry'** . To inculcate this competency following skills are developed in the student after conducting the practical of this laboratory manual

1. Use relevant tools and equipments for dismantling and assembly of various automobile system components.

IV Relevant Course Outcomes -

- Select service tools for relevant service operation in automobile shops.

V Practical Outcome -

- Maintain given automobile component using various Service Tools.

VI Relevant Affective domain unrelated Outcome(s)-

- Follow the road and workshop safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Demonstrate working as a leader/a team member.
- Maintain tools, equipment and service records.

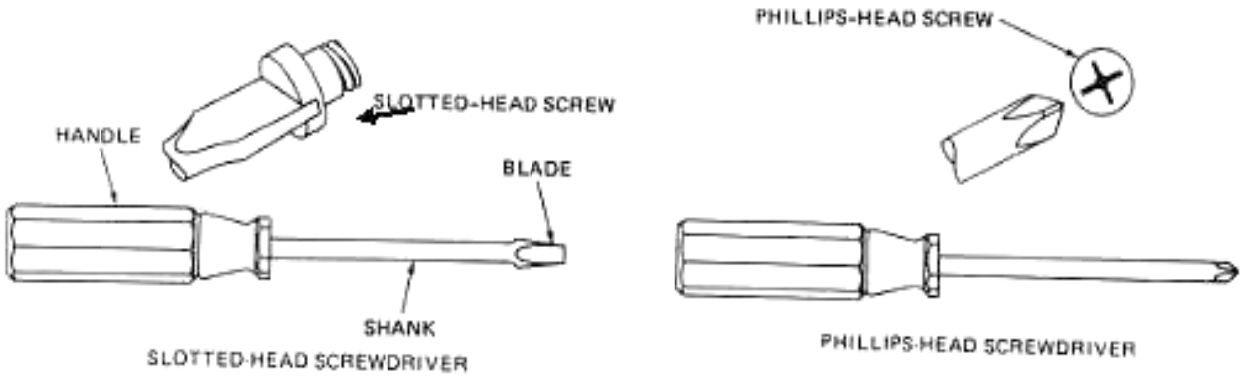
VII Minimum Theoretical Background -

Some commonly used hand tools, measuring tools and special tools are given below-

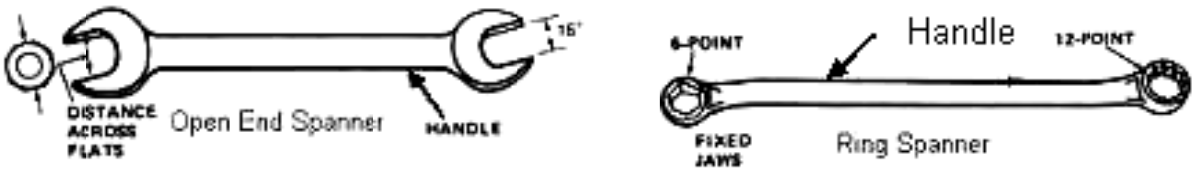
a. Hand tools:

1. **Screw drivers:** Used to remove or tighten the screws. These are available in flat blade (slotted head) and Phillips head with various sizes. Always select a

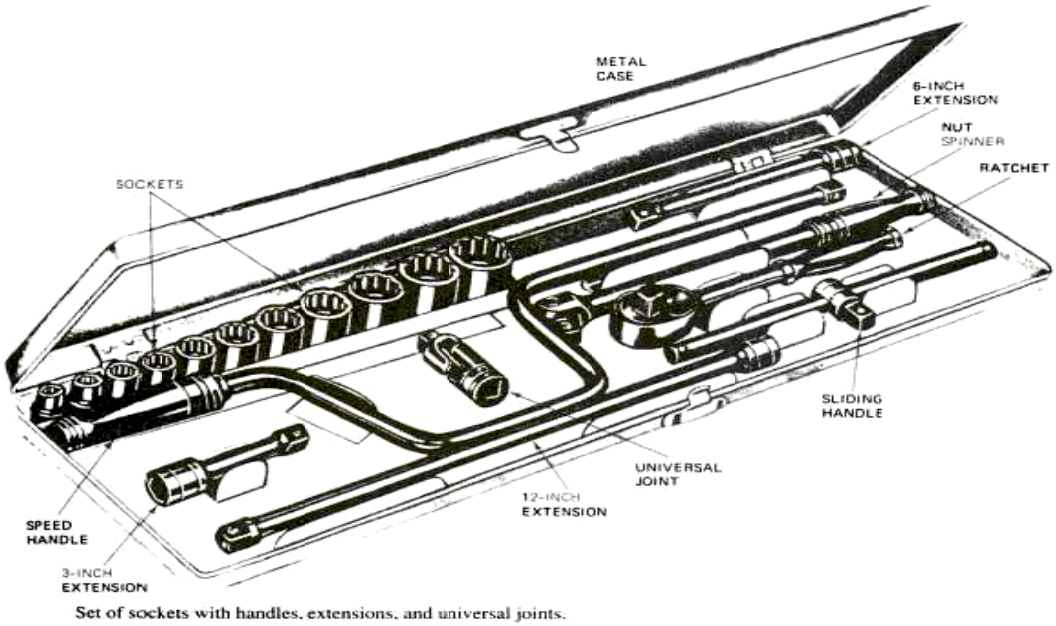
screwdriver of proper type and size for the job. When using a flat blade screwdriver, the blade should completely fill the screw slot. This helps to prevent damage to the screw head.



2. **Spanners**: Used to tighten or loosen the nuts and bolts.
   Open ended spanner: It has a jaw opening at a 15^0 angle to the handle. It hasdifferent sizes on each end. It is used where space restriction is there. Make sure thespanner fits snugly against the bolt or nut, a loose fit may cause slipping of spanner thereby causing injury to mechanic.



Ring spanner: It surrounds the nut or bolt head. It consists of twelve notches which help to hold the bolt properly without slipping.

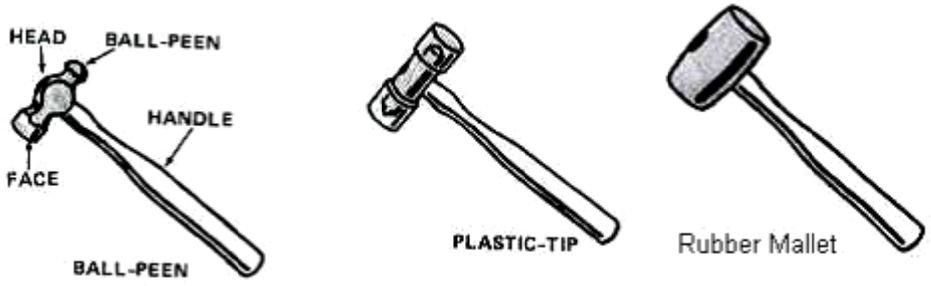


Set of sockets with handles, extensions, and universal joints.

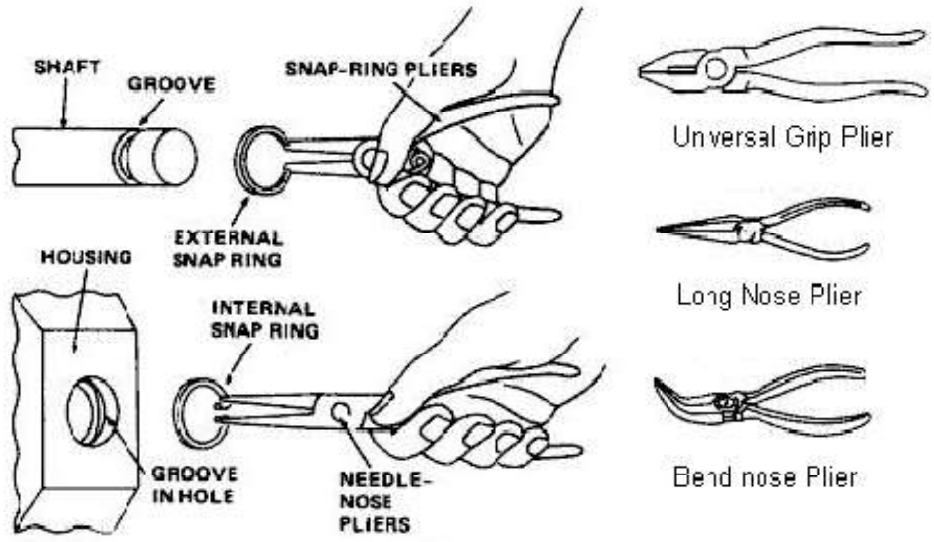
Box spanner: It surrounds the nut or bolt head. It does not slip off.

Socket spanner set: These are most widely used tools in shop. It consists of set of sockets, handle, nut spinners, and ratchet.

3. **Hammers and Mallets:** Hammer is a hand tool used for striking. These are used to make the surface flat. Most commonly used hammer is ball-peen hammer. Care should be taken not to hit the object at an angle.

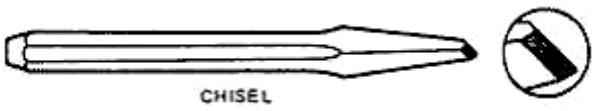


4. **Pliers:** Pliers are hand tools with a pair of adjustable jaws for cutting or gripping. The Snap-ring pliers are used to remove circlips or snap-rings on the shafts or piston pin. Never use pliers on nut or bolt heads these may damage the head.



Internal and External Snap-ring Pliers

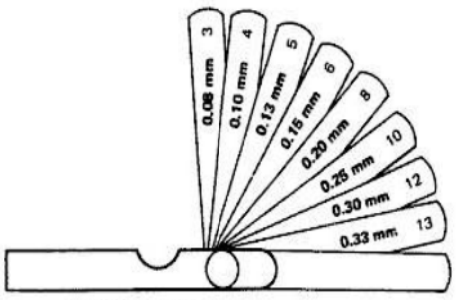
5. **Chisels:** A chisel is a cutting tool with single cutting edge. Always use a protection aids (goggles and hand gloves) when using a chisel. Never use chisel with mushroomed head.



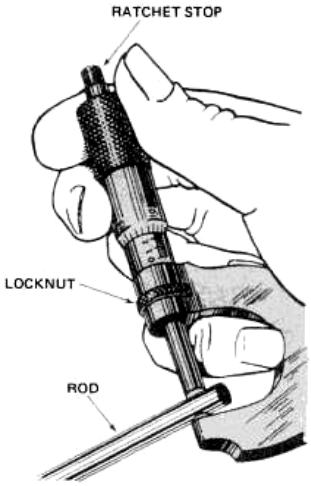
b. Measuring Tools: These are used to measure the dimensions of components so as toidentifyworn or damaged parts of automobile. The measuring tools may be thicknessgauge, micrometer, dial indicator, vernier caliper, pressure gauge etc.

1. Thickness gauge/feeler gauge: To measure theclearance between two parts.

Example – Clearancebetween release lever and throw-out bearing, Valve clearance, Clearance between gears.

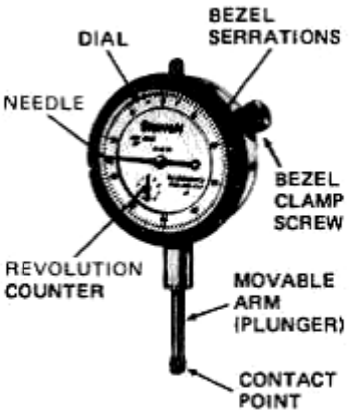


Set of thickness gauges.

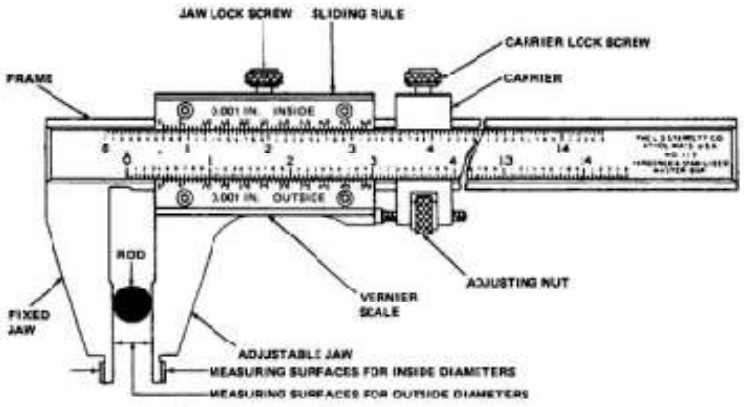


Using an outside micrometer to measure the diameter of a rod.

2. Micrometer: Used for measurement of thicknessor diameter of the components.
   Example- Thickness ofclutch plate, diameter of clutch shaft, gearbox main shaft.These may be inside or outside micrometers.
3. Dial indicator: Measure end play of shafts orgears.
   Example- End play of gearbox shaft, end play offlywheel, backlash of gears.



Dial Indicator



Vernier Caliper

4. Vernier Caliper: To measure inside and outsidedimension of the components.
   Example - Thickness of a plate,diameter of a rod.
5. Pressure gauge: To check the pressure in thesystem.
   Example-Tyre pressure, pressure in fuel line,pressure in power steering pump and pressureinautomatic transmission.

Pressure Gauge

c. Special Tools:

1. **Torque wrench:** This is basically a special handle for socket. An indicator on the torque wrench measures the torque or twisting force. When torque wrench indicates the specified torque, the nut or bolt is properly tightened.

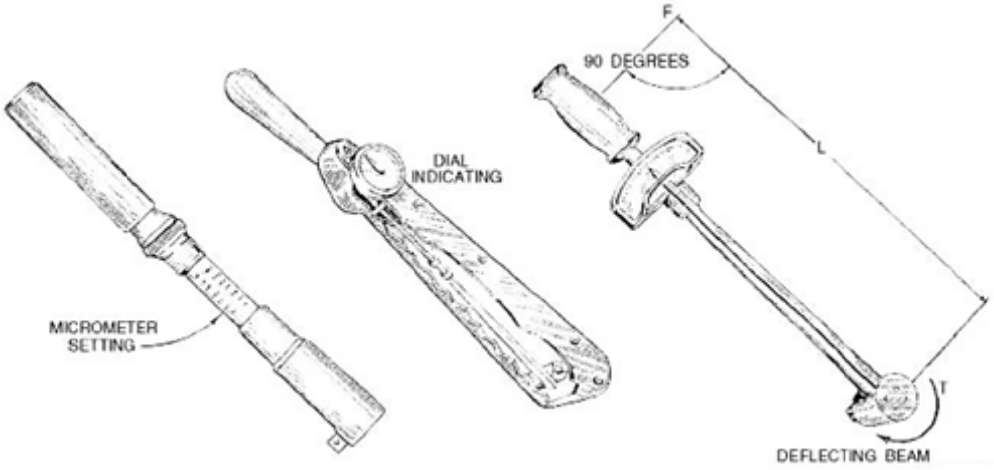


Figure16.1: Torque Wrenches

2. Broken stud/screw remover: Use to remove broken bolts or studs. Center punch the broken bolt and then drill it, use an broken screw remover of proper size to remove the bolt, turn it clockwise to lock the tool and then turn anticlockwise to remove the broken stud. Be careful while using broken screw remover as it is hard and brittle, the excessive force may cause it to break which is more difficult to remove.

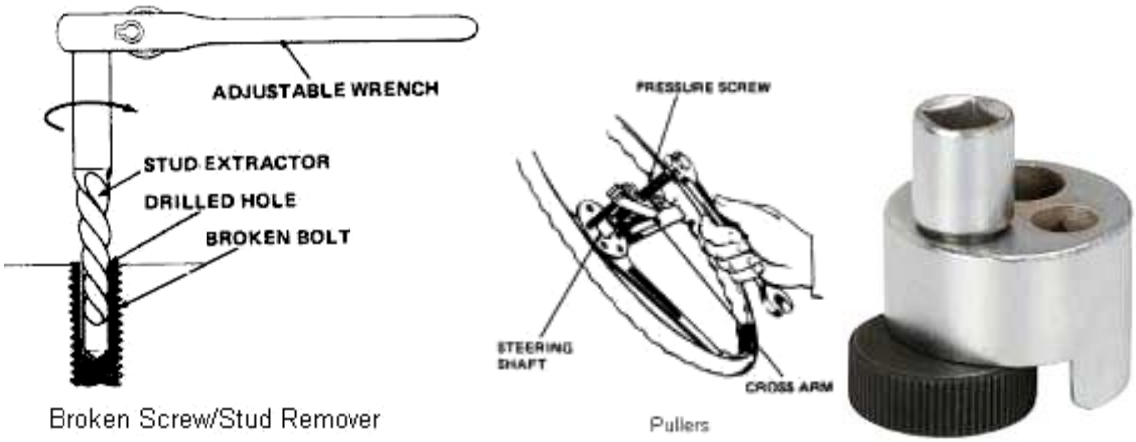


Figure16.2:Stud Extractor

3. **Stud extractor:** This is used to remove the stud without damaging the threads. The stud extractor is held on stud threads and is then rotated by using tommy bar in anticlockwise direction to remove stud without damaging it. Use proper size of hole of stud extractor as per size of bolt.

VIII Practical Set up Diagram :-

Teacher shall arrange all tools and equipments open for observation. Demonstrate operation of different general tools, special tools and equipments with safety precautions to be taken during use. The student shall be given the opportunity to handle the tools.

IX Resources required:-

S. No.	Instrument/Components	Specification	Quantity	Remarks
1.	Basic hand tools	Open End spanner set, Ring spanner set, Socket spanner set, Hammer and Mallet set Pliers, Screw drivers, Allen key set.	1 set	
2.	Measuring tools & Gauges	Vernier Caliper, Micrometer Screw gauge, Feeler/ Thickness gauge, Dial Indicator, Pressure gauge	1 set	
3.	Special Purpose tools	Torque Wrench, Stud extractor, Broken stud/screw remover	1 set	

X Precautions:

1. Select proper hand tools and measuring devices according to job requirement.
2. Take safety precautions while handling the tools.
3. Handle measuring instruments and devices carefully.

XI Procedure:

1. Identify the given tools and equipments.
2. Categorize the tools and equipments according to their use/purpose and type.
3. Use the given tools and equipments for their specified purposes.
4. Refer the service manuals wherever required.
5. List the safety precautions to be taken while handling given tools and equipments.

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.			
2.			
3.			
4.			
5.			
6.			

XIII Actual procedure followed -

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XIV Precautions followed:

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XV Observations and Calculations:

Table 1: Use of tools

S. No.	Name of Tool	Purpose	Application	Precautions taken while using
1	Open Ended Spanner	To open the Bolts and Nuts.	Used where accessibility is good.	Proper size should be selected which fits snugly against the bolt or nut to avoid slipping making injury to the person.
2	Ring Spanner			

3	Socket Spanner			
4	Plier			
5	Screw Driver			
6	Hammer			
7	Thickness Gauge			
8	Vernier Caliper			
9	Micrometer			
10	Pressure Gauge			
11	Torque Wrench			
12	Stud Extractor			

XVI Results:

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XVII Interpretation of results :

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XVIII Conclusions & Recommendation

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XIX Practical related Questions:-

1. Name the make of screw driver used by you in the laboratory.
2. Write the sizes of open end spanner used by you in laboratory.
3. Write the number of sockets, number of ratchets and number of extension rods in the socket spanner set.

[Space for Answers]

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XX References / Suggestions for further Reading:

1. 'Automotive Mechanics' - Crouse, William H; Anglin Donald L; McGraw Hill Education
   (India) Pvt. Ltd. 2006 ISBN 13: 9780070148604
2. 'Basic Automobile Engineering'- Nakra, C. P., DhanpatRai Publication Co. (P) Ltd., New
   Delhi, 2009, ISBN-13: 9788187433224
3. Vehicle Service manual

XXI Assessment Scheme:-

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of tools/equipment	20%
2	Selection and use of proper tools/equipment	20%
3	Timely completion of manual	20%
Product related (10 Marks)		**40%**
4	Interpretation of result & Conclusions	20%
5	Practical related questions	20%
	Total (25 Marks)	**100 %**

Names of Student Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	