Parala Maharaja Engineering College
A CONSTITUENT COLLEGE OF B.P.U.T GOVT. OF ODISHA

LABORATORY MANUAL

(PC 16) Automotive Chasses Lab (AC)

Department of

Automobile Engineering

Laboratory Location: Ground floor of workshop 2, Room no- LB/104

SEMESTER-V

Parala Maharaja Engineering College, Berhampur
A Government Engineering College affiliated to
Biju Patnaik University of Technology, Odisha, Rourkela, India
ପାରଳା ମହାରାଜା ଯାନ୍ତ୍ରିକ ମହାବିଦ୍ୟାଳୟ, ବ୍ରହ୍ମପୁର
(ସରକାରୀ ଯାନ୍ତ୍ରିକ ମହାବିଦ୍ୟାଳୟ)

SAFETY IN THE LAB

- You are only allowed in the laboratory when there is a 'responsible person' present such as a demonstrator or the laboratory staff.

- Do not touch any equipment or machines kept in the lab unless you are asked to do so.

- A tidy laboratory is generally safer than an untidy one, so make sure that you do not have a confused tangle of electrical cables. Electrical equipment is legally required to be regularly checked, which means it should be safe and reasonably reliable: do not tamper or attempt to repair any electrical equipment (in particular, do not rewire a mains plug or change a fuse - ask one of the laboratory staff to do it). Never switch off the mains using the master switches mounted on the walls. Please make yourself aware of the fire exits when you first come into the lab. When the alarm sounds please leave whatever you are doing and make your way quickly, calmly and quietly out of the lab. You must always follow instructions from your demonstrators and the laboratory staff.

- You must keep walkways clear at all times and in particular coats and bags must be stowed away safely and must not pose a trip hazard.

- It is important that you make a point of reading the "Risk Assessment" sheet included in the manuscript of each experiment before you start work on the experiment.

- Please take notice of any safety information given in your scripts. If an experiment or project requires you to wear PPE (personal protective equipment) such as gloves and safety glasses, then wear them.

- Always enter the lab wearing your shoes. It is strictly prohibited to enter the lab without shoes.

- There must be NO smoking, eating, drinking, use of mobile phones or using personal headphones in the laboratory. This last point is not because we dislike your choice of music but because you must remain aware of all activity around you and be able to hear people trying to warn you of problems.

- Keep the lab neat and clean.

List of experiments

Experiment- 01

Study and measurement of the chassis frames Heavy duty vehicle frame (Leyland, Tata etc)

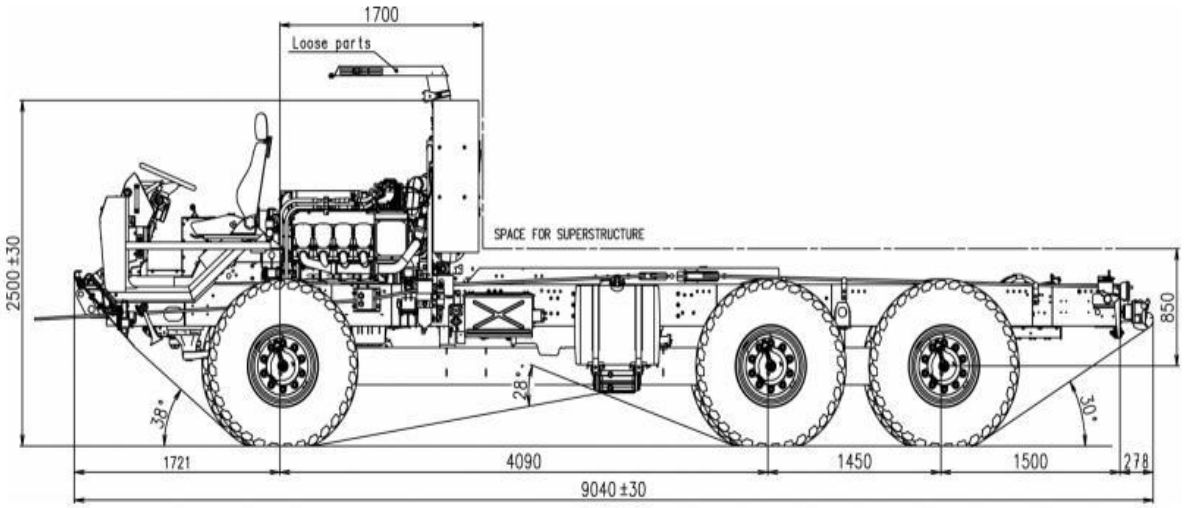
Objective of the experiment: The study and measurement of chassis frames involves analyzing structural design, materials, dimensions, and performance characteristics.

Heavy-Duty Vehicle Frame (Leyland, Tata, etc.)

Applications: Trucks, buses, trailers.

Key Features:

- Material: High-strength steel or alloy steel for durability.
- Design: Ladder frame (most common) for strength and load-carrying capacity.
- Dimensions: Larger, thicker cross-sections, typically C or I-beam profiles.
- Load Capacity: Designed for heavy loads (over 16 tons).
- Suspension Mounts: Leaf springs, air suspension, or multi-link setups.
- Strength Considerations: Tensional rigidity, bending resistance, and fatigue strength.



(Measurement of heavy vehicle chassis with dimension)

Measurement Parameters:

- Length, width, and height of the frame.
- Cross-section dimensions of the rails and cross-members.
- Frame thickness and reinforcement plates.
- Weight distribution and axle positioning.

Key Measurement Tools:

- Vernier Callipers: For small dimensions.
- Micrometers: For thickness measurements.
- Measuring Tape: For larger frame dimensions.

(Model of C- cross section type ladder chassis available at workshop 2)

Conclusion:

Experiment-2

Study and measurement of the chassis frames Light duty vehicle frame (Ambassador, Maruti van etc)

Objective of the experiment: The study and measurement of light duty chassis frame involves analyzing structural design, materials, dimensions, and performance characteristics.

Light-Duty Vehicle Frame (Ambassador, Maruti Van, etc.)

Applications: Passenger cars, vans etc.

Key Features:

- Material: Mild steel or aluminium for weight reduction.
- Design: Ladder frame (older models), monocoque/unibody (modern cars).
- Dimensions: Smaller, lighter cross-sections with rectangular or box profiles.
- Load Capacity: Typically up to 3 tons.
- Suspension Mounts: Independent suspension, Macpherson struts, or leaf springs.
- Strength Considerations: Impact absorption, crash resistance, and overall stability.

Measurement Parameters:

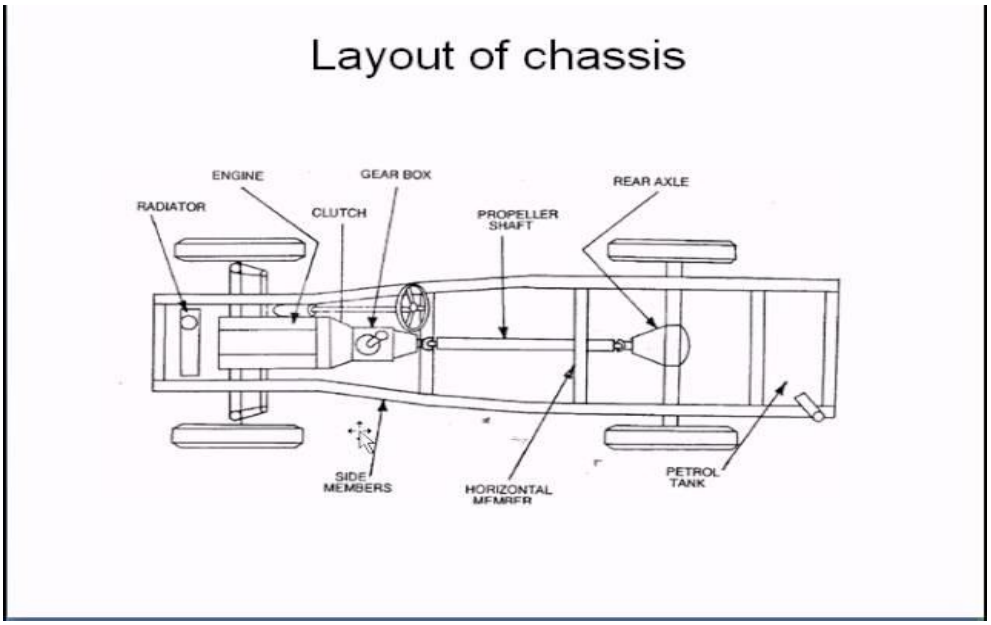
- Frame length, width, and height.
- Cross-section dimensions of rails and supports.
- Material thickness and weld quality.
- Ground clearance and mounting points.

Key Measurement Tools:

- Vernier Callipers: For small dimensions.
- Micrometers: For thickness measurements.
- Measuring Tape: For larger frame dimensions.

Measurement Parameters:

- Length, width, and height of the frame.
- Cross-section dimensions of the rails and cross-members.
- Frame thickness and reinforcement plates.
- Weight distribution and axle positioning.



Conclusion:

Experiment-3

Study and measurement of the Front Axle

Objective:

- To measure various dimensions of a front axle.
- To understand the importance of front axle measurements in vehicle performance.

Tools and Equipment:

- Vernier calliper
- Micrometer
- Measuring tape
- Dial gauge
- Surface plate
- Torque wrench

Components to Measure:

1. Overall Length: Measure the total length of the front axle.
2. Beam Thickness: Measure the thickness of the axle beam at different points.
3. Kingpin Diameter: Measure the diameter of the kingpin bore.
4. Spring Seat Dimensions: Measure the width and height of spring seats.
5. Camber Angle (if applicable): Use a camber gauge to measure the axle's camber.
6. Wheel Track: Measure the distance between the centers of the two front wheels.

(Model of front axle located in AC Lab)

Procedure:

1. Clean the front axle thoroughly.
2. Place the axle on a surface plate or workbench.
3. Use appropriate measuring tools to measure dimensions.
4. Record measurements accurately.
5. Compare with manufacturer specifications.

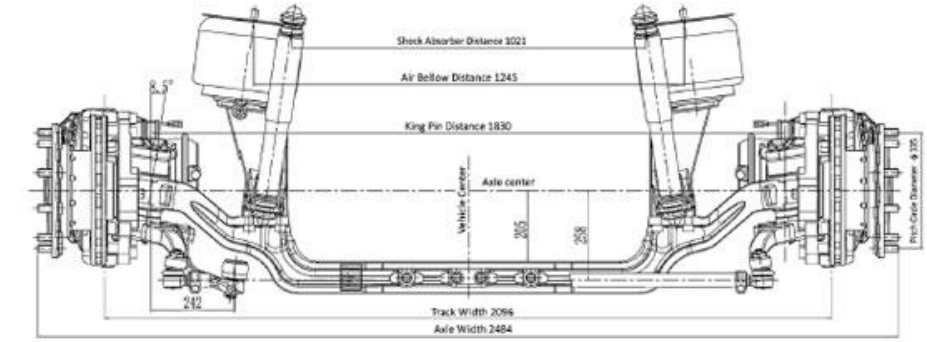
Precautions:

- Ensure proper calibration of measuring tools.
- Take measurements at multiple points for accuracy.
- Handle tools and components with care to avoid damage.

Observations and Data Table:

Measurement Component	Measured Value	Specified Value	Deviation
Overall Length			
Beam Thickness			
Kingpin Diameter			

Installation dimensions



Unit: mm

Note: The picture shows low floor bus front axle BFA 81R.
For other sizes, please contact GK DRIVE SYSTEMS.

Conclusion:

Experiment-4

Study and measurement of the Rear axle

Objective:

- To study the construction, working, and types of rear axles.
- To measure critical dimensions and parameters of the rear axle assembly.

Tools and Equipment:

- Vernier calliper
- Micrometer
- Measuring tape
- Dial gauge
- Torque wrench

Components to Measure:

A. Axle Housing Measurements:

1. Overall Length: Total length of the axle housing.
2. Outer Diameter: Measure the outer diameter at multiple points.
3. Wall Thickness: Measure wall thickness using a micrometer.
4. Mounting Flange Dimensions: Check flange diameter, bolt hole size, and PCD (Pitch Circle Diameter).

B. Differential and Axle Shaft Measurements:

1. Crown Wheel Diameter: Measure the outside diameter.
2. Pinion Gear Dimensions: Measure pinion length and diameter.
3. Axle Shaft Length: Measure the axle shaft's total length.
4. Spline Details**:** Count the number of splines and measure spline width and depth.

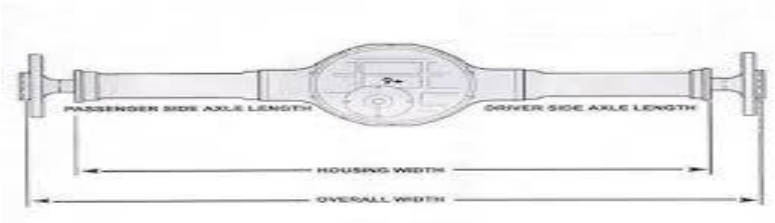
Types of Rear Axles:

- Semi-Floating Axle
- Full-Floating Axle
- Three-Quarter Floating Axle

Procedure:

1. Visual Inspection: Examine the axle for signs of wear, damage, or cracks.
2. Mounting and Setup: Place the axle housing on a surface plate.
3. Measurement Steps:
    - Use measuring tools like vernier calipers, micrometers, and measuring tapes.
    - Record all key dimensions, taking multiple measurements at different points.
4. Check for Tolerances: Compare the measured values with manufacturer specifications.

(model of rear axle located in AC lab)



Precautions:

- Use calibrated measuring tools.
- Handle heavy components with care.
- Take measurements at different points to ensure accuracy.

Observation Table:

Measurement Component	Measured Value	Specified Value	Deviation
Axle Housing Length			
Outer Diameter			
Wall Thickness			
Crown Wheel Diameter			
Pinion Gear Diameter			
Spline Count & Size			

Conclusion:

Experiment -5

Study and measurement of the differential

Objective:

- To study the construction, working, and types of differentials.
- To measure key dimensions of a differential assembly.

Tools and Equipment:

- Vernier calliper
- Micrometer
- Measuring tape
- Feeler gauge
- Dial gauge
- Torque wrench

Components of the Differential:

1. Crown Wheel (Ring Gear)
2. Pinion Gear
3. Differential Case
4. Bevel Gears (Spider Gears)
5. Side Gears (Sun Gears)
6. Axle Shafts
7. Bearing Caps

Working function of differential:

The function of a differential is to transmit power from the engine to the axle that moves the wheels and allow the wheels to move at different speeds from each other. When the fluid is compromised or deteriorated, increased heat and friction can cause the gears to not function smoothly.

Procedure:

A. Study Section:

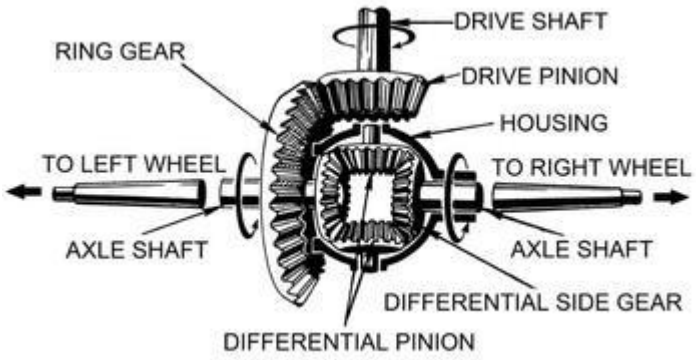
1. Identify various parts of the differential.
2. Understand how power is transmitted through the differential assembly.

B. Measurement Section:

1. Crown Wheel and Pinion Measurement:
    - Measure the outer diameter of the crown wheel.
    - Count the number of teeth on both the crown wheel and pinion gear.
    - Measure the gear module (pitch circle diameter/number of teeth).
2. Bevel Gears (Spider Gears):
    - Measure the gear diameter and width.
3. Bearing Measurements:
    - Measure the inner and outer bearing diameters.
4. Backlash Measurement:
    - Mount the differential assembly on a workbench.
    - Use a dial gauge to measure the backlash between the crown wheel and pinion.
5. Clearance Check:
    - Use a feeler gauge to check side gear and spider gear clearance.

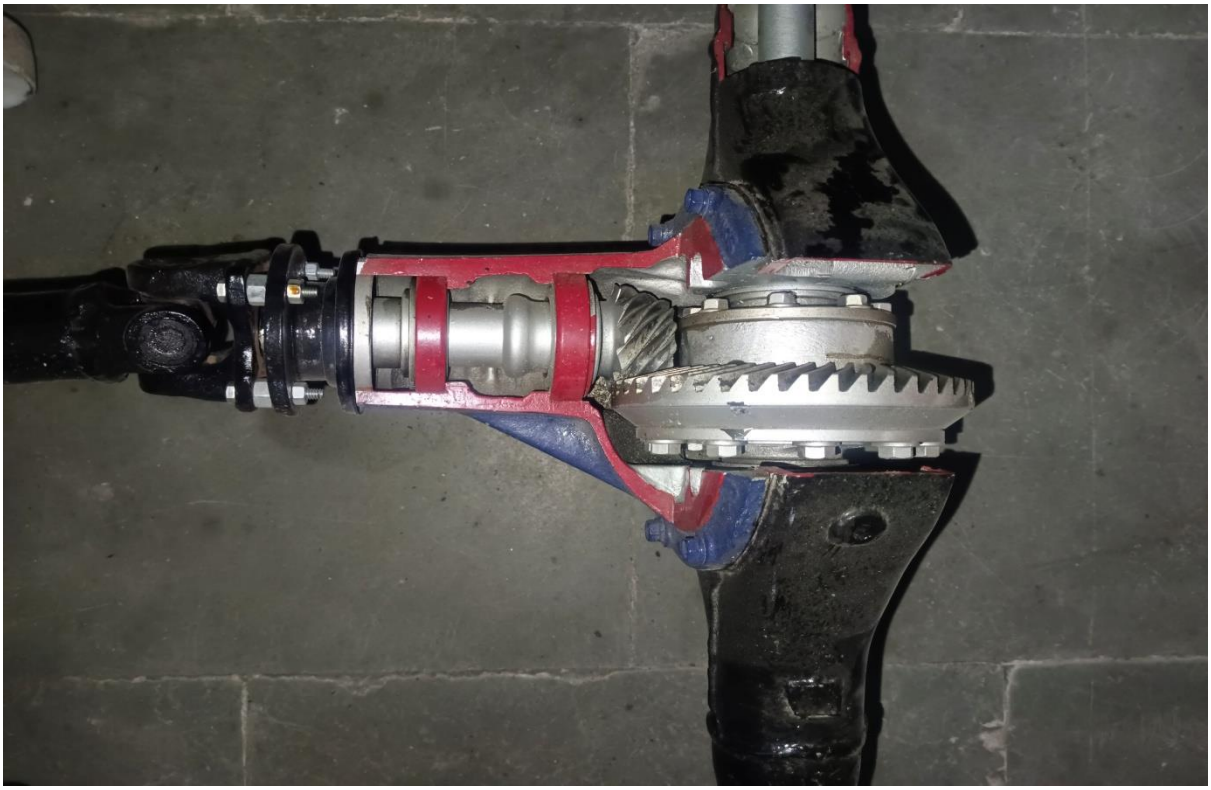
Precautions:

- Use calibrated tools for precise measurements.
- Avoid damaging the gear teeth while measuring.
- Take multiple readings for accuracy.



Observation Table:

Measurement Component	Measured Value	Specified Value	Deviation
Crown Wheel Diameter			
Pinion Gear Diameter			
Gear Tooth Count			
Backlash (mm)			
Bevel Gear Diameter			



(cut section of differential available in AC lab)

Conclusion:

- Summarize the condition and suitability of the differential components.
- Note any deviations and suggest corrective measures or repairs.

Experiment-6

Study and measurement of the Steering systems along with any two types of steering gear box

Aim of the experiment:

To study, dismantling and assembling of steering system gear box along with its advantages and disadvantages.

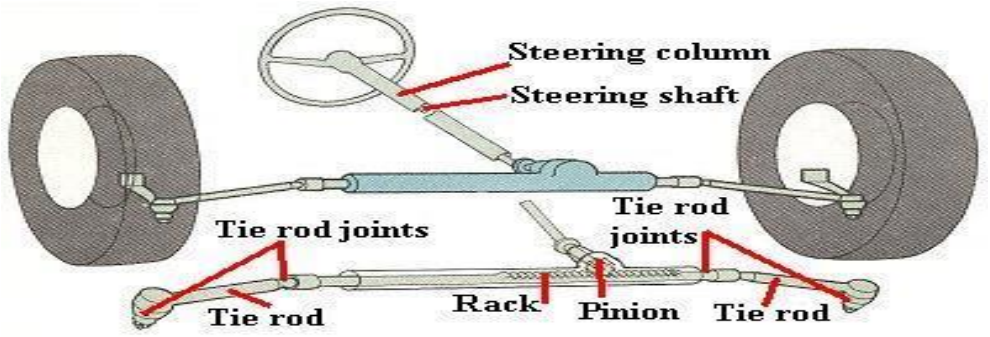
Apparatus required:

Model of rack and pinion gear box

Theory:

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.

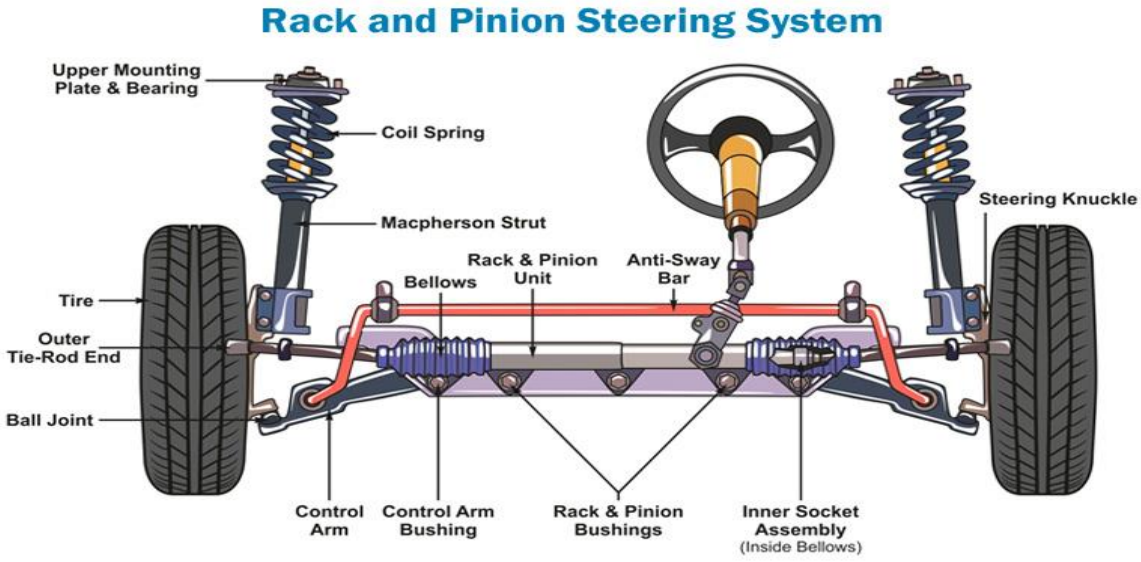
The manual rack-and-pinion steering gear basically consists of a steering gear shaft, pinion gear, rack. Thrust spring, bearings, seals, and gear housing. In the rack-and- pinion steering system the end of the steering gear shaft contains a pinion gear, which meshes with a long rack. The rack is connected 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 isolated, 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.

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 thread sand left hand threads at tie rods.



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.Disconnectthenegativebatterycable.Removetheupperandlowersteeringcolumn covers.
2. Disconnectuniversaljointfromthegearhousing.Placematchmarksbeforeremoving set bolts.
3. Raise and safely support the vehicle.
4. Remove both front wheels.
5. Remove the cotter pins from both tie rod joint sand 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.
   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:

1. Inspect rack and pinion for undue wear.
2. 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.
3. Inspect the bellows for damage, and replace if needed. See the vehicle workshop manual for replacement instructions.

Assembling:

1. Installtherackassembly.Secureitwiththeretainingboltsandnutsandtighten them EVENLY to 58 Nm.
2. 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.
3. Install the front wheels.
4. Lower the car to the ground.
5. Align match marks and connect universal joint to the steering gear housing. Tighten the upper and lower set bolts to 35 Nm.
6. 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.

Conclusion:

Experiment-7

Study and measurement of the Braking systems – hydraulic servo vacuum, compressed air power brakes.

Aim of the experiment:

To study, dismantling and assembling of braking system with advantages and disadvantages.

Apparatus required :

Model of drum/disk brake.

Theory:

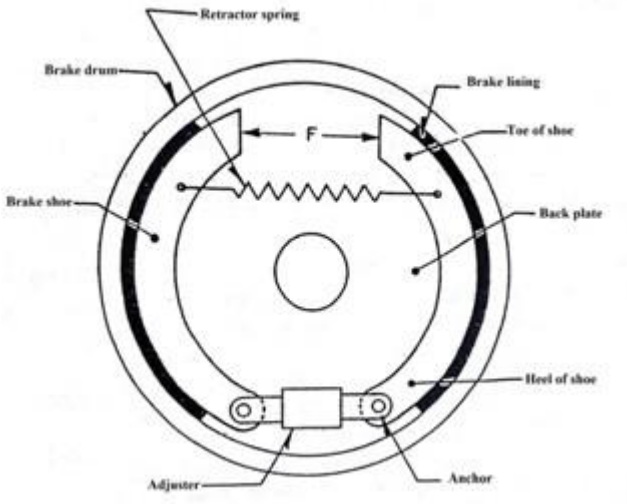
When a vehicle is moving it contains energy of motion (kinetic energy) and the function of the braking system is to convert this kinetic energy into heat energy. It does so through the friction at the brake linings and the brake drum, or the brake pads and the disc.
Two basic types of friction brakes are in common use on vehicles;
These are:

1. Drum brake
2. Disk 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.

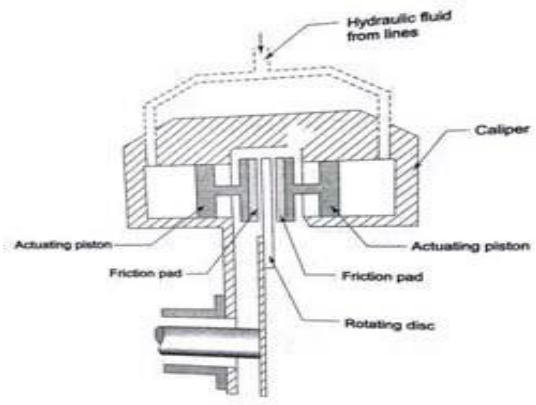


(Line diagram of drum brake)

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 calliper 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 calliper 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 caliper 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.



(line diagram of disc brake)

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

Procedure

Drum Brake

- ### Dismantling:

Raise and safely support the vehicle.

a. Remove the wheel from the vehicle.
b. Apply the parking brake and remove
c. Remove the attaching nuts.
d. Release the parking brake and remove the brake drum.
e. Remove the spring from this condary shoe to the adjusting lever.
f. Remove the adjusting lever, return spring, and hold down pin clips.
g. Remove the primary shoe.
h. 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. Shoes lading surface for excessive wear and damage
3. Check back plate for damage, cracks, and deform at
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 these canary 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 wheel sand 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. Checkpistonsurfaceforcorrosion,wear,anddamage.Replacepistonasn ecessary.
  2. Checkslidingpins,slidingpinboltsandslidingpinbootsforwear,dama ge, and cracks. Replace applicable part as necessary.
  3. Usingamicrometre,checkthicknessofdiscrotor.Ifthicknessisoutside the standard, replace disc rotor.

- **Assembling:**
  1. While assembling, dip each parting clean brake fluid.
  2. Whilefittingthepistonandthepistonsealtothecylinderapplysomeam ount 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 pad sand disc brake caliper. Connect the brake pipe line.
  6. Bleed the system and test it.

Conclusion:

Experiment-8

Study and measurement of the Leaf spring, coil spring, torsion bar spring, Hydraulic shock absorber

Aim of the experiment:

To study, dismantling and assembling of leaf spring.

Tools required:

Spanners, hammer, pliers.

Material required:

Leaf spring, steel rule, grease, cotton waste

Theory:

This is the most widely used suspension system. In which the semi elliptical type is the important. This spring consist of number of springs called blades. The large blade is called master blade. The master blade has eye on its ends is fixed and bolted rigidly on frame and other end fixed by means of a shackle. This helps to adjust the length of the spring while vehicle is running on irregular road. Elliptical spring, quarter elliptical spring and transverse elliptical spring are the other type of leaf spring used in a vehicle in case of heavy vehicle helper spring also used to carry the load.

Procedure:

a) Dismantling

1. park the vehicle on a level ground and jack up the vehicle on front axle on both ends.
2. Lift the chassis frame at position one just behind shackle and one end joint.
3. Loosen the U-bolt attached to the axle and remove the connection from the shackle spring by removing the pin and take out the leaf and clean well.
4. Loosening the lock nut of the centre bolt and loosen the clamp bolt by strip bolt take the master leaf from the assembly of the leafs.

Inspection and cleaning:

1. Check the leaf spring, it is done by checking centre to end distance and height at either side by means of steel rule.
2. Check and remove brake spring and lubricate the spring by grease.
3. Check for worn bearing, loosen eye cranks, lever broken shackles.

Re assembling:

1. Assemble the leaf that has been dismantled.
2. Tight the lock nut on centre of master leaf and tight the gland nut.
3. Take the spring assembly to the vehicle.
4. Place the leaf spring on spring seat of rear axle and tighten the U-bolt assembly.
5. Reconnect the leaf assembly and provide the pinion leaf.
6. Remove the stand from chassis and remove the screw jack.

Conclusion: Studied, dismantled, and assembled the leaf spring.

Experiment-9

Study and measurement of the gear box

Objective:

- To study the construction, working, and types of gear box.

Tools and Equipment:

- Vernier calliper
- Micrometer
- Measuring tape
- Dial gauge
- Feeler gauge
- Torque wrench
- Gear tooth calliper

Components of a Gear box:

1. Input Shaft
2. Output Shaft
3. Countershaft
4. Gears (Spur, Helical, Bevel, etc.)
5. Synchronizers
6. Bearings and Bushings
7. Selector Forks
8. Gear Shifter Mechanism
9. Casing (Housing)

Working function of gear box:

- To provide for disconnecting the engine from the driving wheels.
- When the engine is running, to enable the connection to the driving wheels to be made smoothly and without shock.
- To enable the leverage between the engine and driving wheels to be varied.
- It must reduce the drive-line speed from that of the engine to that of the driving wheels in a ratio of 3:1 and 10:1 or more, according to relative size of engine and weight of vehicle.
- Enable the driving wheels to rotate at different speed.
- Provide for relative movement between the engine and driving wheels.

Measurement Section:

1. Gear Measurement:
    - Outer Diameter (Do): Use a vernier caliper to measure the gear's outer diameter.

    - Module (m): Measure the gear's module using:

      $$m=D/Z$$

      Where:

        - D = Pitch Circle Diameter
        - Z= Number of Teeth

    - Face Width: Measure the width of the gear face.
    - Tooth Thickness: Measure the thickness of individual gear teeth using a gear tooth calliper.

- Shaft Measurement:
    - Measure the diameter and length of the input, output, and countershafts.
- Clearance Check:
    - Use a feeler gauge to check gear backlash and gear clearance.
- Bearing Measurement:
    - Measure inner and outer bearing diameters.

- Gear Ratio Calculation: No of teeth on driven gear/No of teeth on driving gear

Precautions:

- Use properly calibrated measuring instruments.
- Handle gearbox components carefully to avoid damage.
- Take multiple measurements for better accuracy.
- Ensure the gearbox is securely mounted during inspection and measurement.

Tabulation:

Measurement Component	Measured Value	Specified Value	Deviation
Gear Outer Diameter (mm			
Gear Module (mm)			
Shaft Diameter (mm)			
Gear Tooth Count			
Backlash (mm)			
Bearing Inner Diameter (mm)			

Conclusion:

Experiment-10

Study and measurement of the transfer case

Objective:

- To study the construction, working, and types of transfer cases.

Tools and Equipment:

- Vernier caliper
- Micrometer
- Measuring tape
- Dial gauge
- Feeler gauge
- Torque wrench
- Gear tooth caliper
- Surface plate

Components of a Transfer Case:

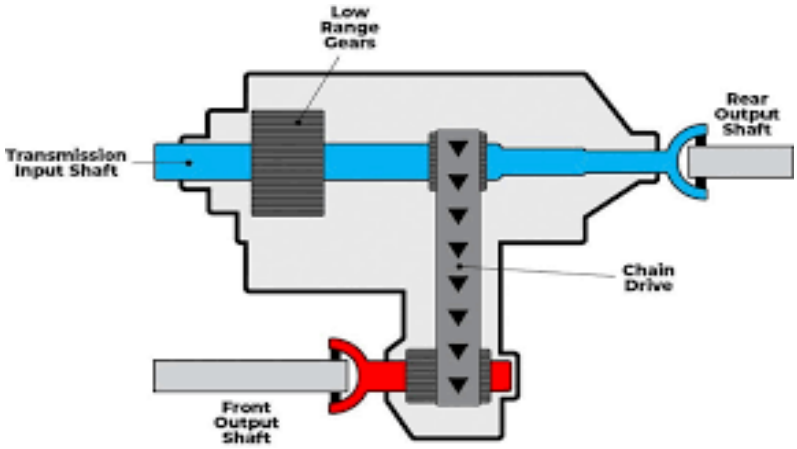
1. Input Shaft
2. Output Shafts (Front and Rear)
3. Drive Chain or Gears
4. Planetary Gears (if applicable)
5. Differential (Center Differential in AWD)
6. Shift Forks and Synchronizers
7. Bearings and Seals
8. Selector Mechanism
9. Casing (Housing)

Theory:

A **transfer case** is a vital component found in many four-wheel drive (4WD) and all-wheel drive (AWD) vehicles. It serves as the mechanical link between the transmission and the front and rear axles. This crucial automotive component plays a pivotal role in distributing power from the engine to all four wheels. Whether you're navigating off-road terrain, traversing slippery road conditions, or simply enhancing vehicle stability, the transfer case is a fundamental part of the drive train that empowers vehicles to conquer a wide range of driving environments.

A transfer case is a crucial component in four-wheel-drive and all-wheel-drive vehicles. It distributes power from the transmission to both the front and rear axles, allowing for better traction and control on various terrains. It plays a vital role in shifting between 2-wheel and 4-wheel drive modes, enhancing a vehicle's off-road capabilities.

The transfer case is a component situated downstream of the vehicle's transmission in 4-wheel drive (4WD) or all-wheel drive (AWD) systems. Its primary function is to facilitate the transmission of power from the vehicle's transmission to both the front and rear wheels. In simpler terms, the transfer case serves as the crucial link between the transmission's output shaft and the front and rear propeller shaft. These propeller shafts, in turn, connect to the front and rear differentials, enabling the distribution of power to all wheels of the vehicle. Additionally, the transfer case also incorporates a drive mode selection feature, allowing the driver to choose between 2-wheel drive (2WD) or 4-wheel drive (4WD) operation.



(Line diagram of transfer case)

Precautions:

- Ensure proper calibration of measuring tools.
- Handle components carefully to avoid damage.
- Take multiple measurements at different points for accuracy.
- Ensure the transfer case is securely mounted on the workbench during inspection.

Conclusion: