Automotive Service Technician

(Job Role)

Qualification Pack: Ref. Id. ASC/Q1402
Sector: Automotive

Textbook for Class XI

विद्यया ऽमृतमश्नुते
एन सी ई आर टी
NCERT
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Foreword

The National Curriculum Framework–2005 (NCF–2005) recommends bringing work and education into the domain of the curricular, infusing it in all areas of learning while giving it an identity of its own at relevant stages. It explains that work transforms knowledge into experience and generates important personal and social values such as self-reliance, creativity and cooperation. Through work one learns to find one's place in the society. It is an educational activity with an inherent potential for inclusion. Therefore, an experience of involvement in productive work in an educational setting will make one appreciate the worth of social life and what is valued and appreciated in society. Work involves interaction with material or other people (mostly both), thus creating a deeper comprehension and increased practical knowledge of natural substances and social relationships.

Through work and education, school knowledge can be easily linked to learners' life outside the school. This also makes a departure from the legacy of bookish learning and bridges the gap between the school, home, community and the workplace. The NCF–2005 also emphasises on Vocational Education and Training (VET) for all those children who wish to acquire additional skills and/or seek livelihood through vocational education after either discontinuing or completing their school education. VET is expected to provide a 'preferred and dignified' choice rather than a terminal or 'last-resort' option.

As a follow-up of this, NCERT has attempted to infuse work across the subject areas and also contributed in the development of the National Skill Qualification Framework (NSQF) for the country, which was notified on 27 December 2013. It is a quality assurance framework that organises all qualifications according to levels of knowledge, skills and attitude. These levels, graded from one to ten, are defined in terms of learning outcomes, which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. The NSQF sets common principles and guidelines for a nationally recognised qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities.

It is under this backdrop that Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal, a constituent of NCERT has developed learning outcomes based modular curricula for the vocational subjects from Classes IX to XII. This has been developed under the Centrally Sponsored Scheme of Vocationalisation of Secondary

and Higher Secondary Education of the Ministry of Education, erstwhile Ministry of Human Resource Development.

This textbook has been developed as per the learning outcomes based curriculum, keeping in view the National Occupational Standards (NOS) for the job role and to promote experiential learning related to the vocation. This will enable the students to acquire necessary skills, knowledge and attitude.

I acknowledge the contribution of the development team, reviewers and all the institutions and organisations, which have supported in the development of this textbook.

NCERT would welcome suggestions from students, teachers and parents, which would help us to further improve the quality of the material in subsequent editions.

HRUSHIKESH SENAPATY
Director
National Council of Educational
Research and Training

New Delhi
September 2020

About the Textbook

India has been witnessing growth in the automotive sector with new developments taking place in all components of automobiles. The automotive manufacturing industry comprises the production of commercial vehicles, passenger cars, three- and two-wheelers, etc. We need trained manpower to carry out the various activities in sales, service and production of automotive products. Automotive Service Technician Level IV involves repairing and servicing of automobile and accessories. An Automotive Service Technician is responsible for installation, minor repair, maintenance and servicing of vehicles. The person should be able to work independently, perform laborious tasks, should be a good listener, good at taking and following instructions, a good team player and result-oriented, with a positive attitude. Automotive Service Technician Level IV is an intermediate-level course for a job role in the automotive sector.

This textbook for the job role of 'Automotive Service Technician' has been developed to impart knowledge skills through hands-on learning experience, which forms a part of the experimental learning. The textbook has been developed with the contribution from subject experts, vocational teachers and industry experts and academicians for making it a useful and inspiring teaching-learning resource material for the vocational students. Adequate care has been taken to align the contents of the textbook with the National Occupational Standards (NOSs) for the job role so that the student acquires the necessary knowledge and skills as per performance criteria mentioned in the respective NOSs of the Qualification Pack (QP).

The NOSs for the job role of 'Automotive Service Technician' covered through this textbook are as follows:

1. ASC/N 1401: assist in service, maintenance and repair of the vehicle
2. ASC/N 0001: plan and organise work to meet expected outcomes
3. ASC/N 0002: work effectively in a team
4. ASC/N 0003: maintain a healthy, safe and secure working environment

Unit 1 of the textbook gives an introduction to engineering drawing. Unit 2 focuses on the various types of fasteners used in the automobile sector. Unit 3 talks about the types of material used for construction of automobile. Unit 4 discusses the measuring equipment, their handling and usage. Unit 5 highlights the importance of regular maintenance of an engine. Unit 6 talks about the transmission system.

Unit 7 explains lubrication and setting of gear box. Unit 8 talks about the types of wheels, hub greasing and bearing play adjustments. Lastly, Unit 9 discusses the repair and maintenance of tubes and tyres, types of brakes, their repair and maintenance.

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Kuber Singh, *Junior Project Fellow* and Avinash Singh, *Consultant*, Department of Engineering and Technology, PSSCIVE, Bhopal, are also duly acknowledged for their contribution in the development of this textbook for vocational skills. The Council is grateful to Saroj Yadav, *Professor* and *Dean* (Academic), NCERT, and Ranjana Arora, *Professor* and *Head*, Department of Curriculum Studies, for evaluating and giving suggestions for the improvement of this book and its finalisation. The Council acknowledges the copy editing and valuable contribution of Shilpa Mohan, *Assistant Editor* (Contractual) and Lalboy, *Editorial Assistant* (Contractual) in shaping this book. The efforts of Pawan Kumar Barriar, *DTP Operator*, and Mohammad Atir, *DTP Operator* (Contractual), Publication Division, NCERT; Akhilesh Kashiv, *Computer Operator*, Vikas Kumar Koge, *Graphic Artist* (Contractual), and Pinki Tiwari, *Graphic Designer* (Contractual) PSSCIVE, NCERT, for flawless layout design are also acknowledged. The Council is also grateful to Automotive Skills Development Council (ASDC), New Delhi for providing photographs for this textbook. The images used other than these are under Creative Commons License.

Contents

Unit 1

Engineering Drawing

Session 1: Basic Geometric Constructions

'Construction' in geometry means to draw shapes, angles or lines accurately, using only compass, straightedge (i.e., ruler) and a pencil. It helps students in developing skills to handle drawing tools and promotes logical thinking.

Engineering drawing is a representation of graphical language, hence, involves geometrical constructions. It provides all the information about an item or product to the user and helps the mechanist or technician to develop the required product.

Tools for Making Geometrical Constructions

Some basic tools are required for making geometrical constructions. These are as given below.

1. Drawing board and stand
2. Tee-square
3. Mini drafter
4. Set square
5. Protractor
6. Instrument box
7. French curves or irregular curves

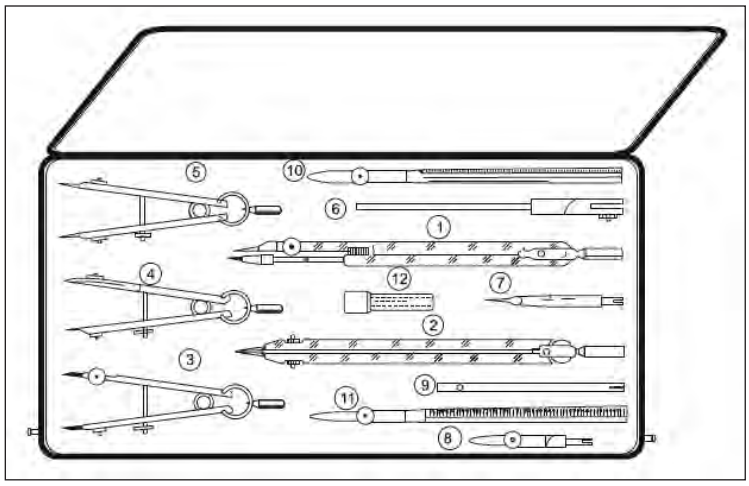


Fig. 1.1: Instruments used for geometric constructions

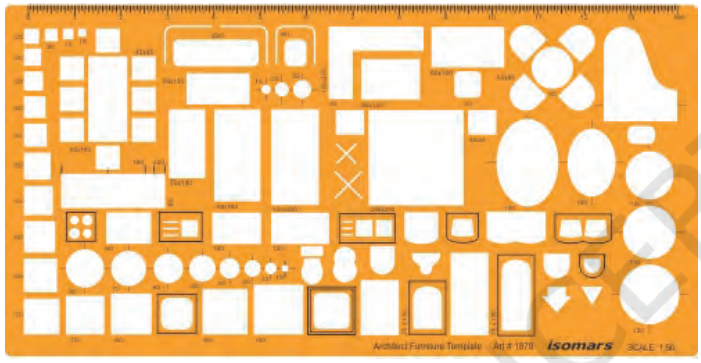


Fig. 1.2: Template

8. Pencil
9. Eraser and erasing shield
10. Blade, pocket knife, or pencil sharpener
11. Drawing pins, adhesive tape, or clips
12. Drawing paper or drawing sheet, tracing
13. paper, and tracing cloth
14. Cloth or brush for dusting
15. Sand paper
16. Scales (engineering scales)
17. Sketchbook

You must have used some of the above instruments in Class IX and X, but the important ones are shown in Fig.1.1.

1. Large-sized compass (150 mm long) with interchangeable legs for pen or pencil
2. Large size divider (150 mm long)
3. Small bow compass (95 mm long)
4. Small ink bow compass (95 mm long)
5. Small bow divider (95 mm long)
6. Lengthening bar

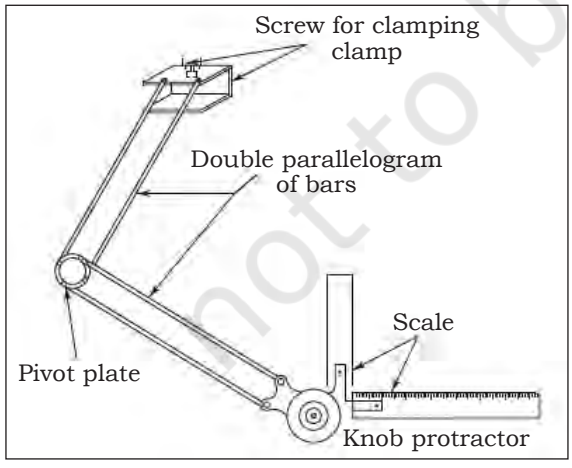


Fig. 1.3: Mini drafter

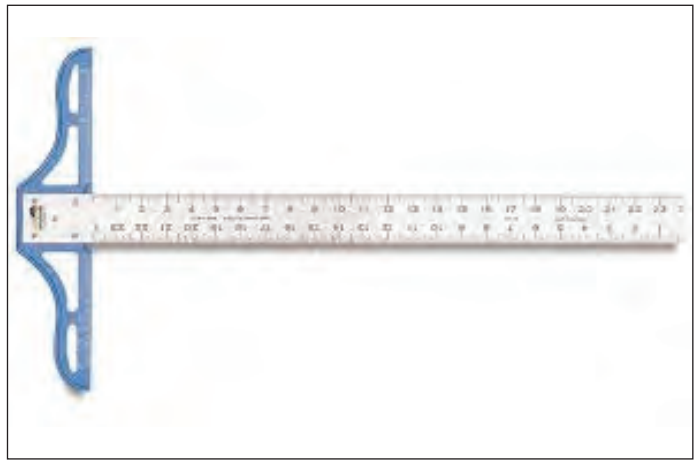


Fig. 1.4: Tee-square

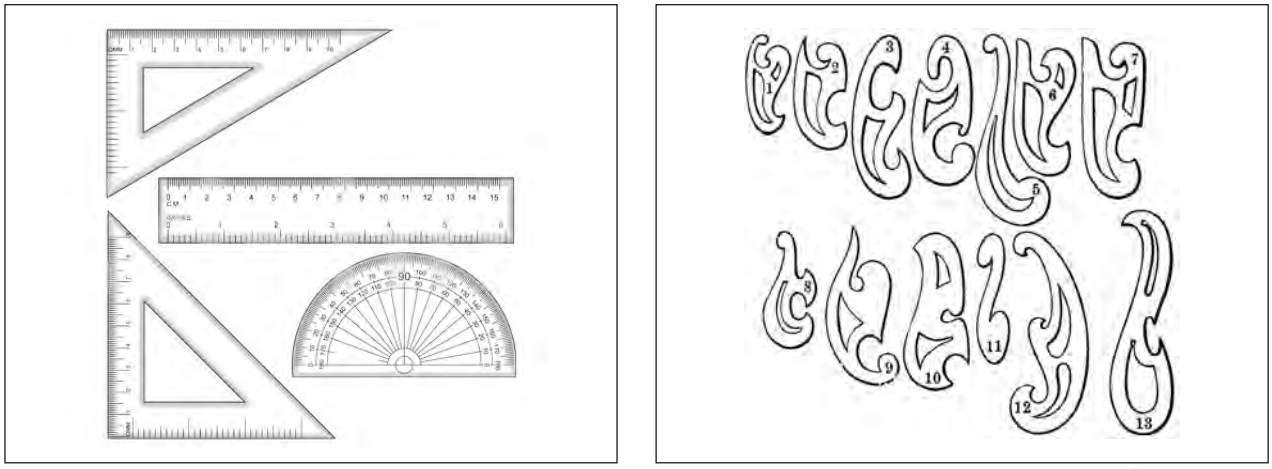


Fig. 1.5: Set squares, scale, protractor and set of French curves

7. Pin point
8. Ink point
9. Ruling pen or liner
10. Holder crow quill (for lines)
11. Lead case (for storing lead)

Methods for Making Geometrical Constructions

Geometric constructions can be used to solve mathematical problems when you do not have numbers. With just two tools you can bisect lines and angles as well as draw circumscribed and inscribed circles.

Example 1

Draw the perpendicular bisector of a given line segment AB

Solution

1. Using a scale draw a line AB of given length.
2. Set a compass more than half the length of AB, and using A as the centre draw arcs as shown in Fig. 1.6.
3. Draw arcs using B as the centre with the compass set as above.
4. Connect the intersection (C and D) by a line.
5. The connecting line CD bisects AB at point M.

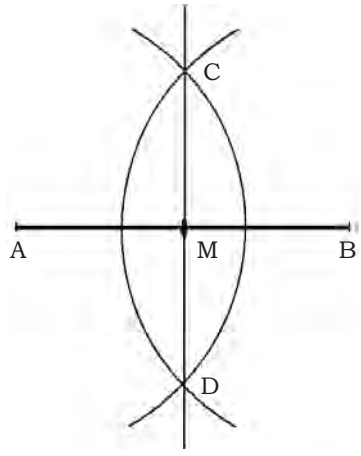


Fig. 1.6: Bisecting a line

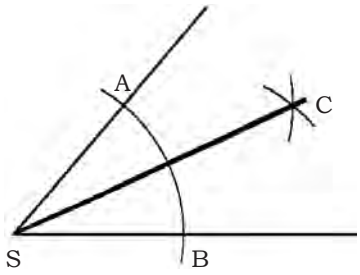


Fig. 1.7: Bisecting an angle

Example 2

Bisect a given angle

Solution

1. Draw any acute angle.
2. To obtain points A and B on the lines, draw an arc with S as the centre as shown in Fig. 1.7.
3. Using A and B as the centre draw arcs, which intersect at point C.
4. The connecting line CS bisects the acute angle SAB.

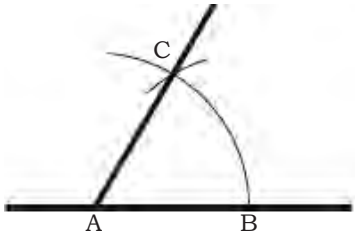


Fig. 1.8: Constructing an angle of 60°

Example 3

Construct an angle of 60°

Solution

1. Using a scale draw a straight line and mark point A on it as shown in Fig. 1.8.
2. Open compass to a suitable length, place needle of the compass on point A and draw an arc, thus intersecting the line at point B.
3. Keeping the compass opening same, place the compass needle on point B and draw an arc intersecting the same arc at point C.
4. Join AC. Angle BAC is the required angle of 60°.

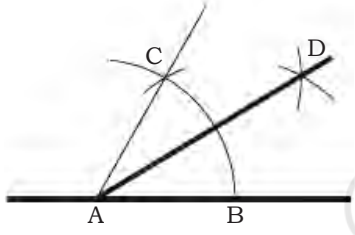


Fig. 1.9: Constructing an angle of 30°

Example 4

Constructing an angle of 30°

Solution

1. Using a scale draw a straight line and mark point A on it.
2. Open a compass; draw an arc by placing the compass needle at point C. Similarly, draw an arc by placing the needle at point B thus intersecting the arc at point D.
3. Join AD. Angle DAB is of 30°(Fig. 1.9).

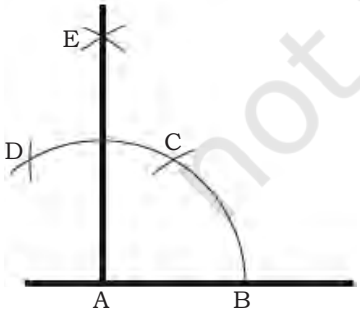


Fig. 1.10: Constructing an angle of 90°

Example 5

Constructing an angle of 90°

Solution

1. Using a scale, draw a straight line. Mark a point A on it.
2. Open compass to a suitable length, place the compass needle at point A and draw an arc

intersecting the line at point B. Do not change the opening of compass for the next steps.

3. By placing the needle at point B intersect the arc at point C.
4. Similarly, place the compass needle at point C and intersect the arc at point D.
5. Taking C and D as centres draw arcs intersecting at point E. Join AE.
6. Angle EAB is of 90°(Fig. 1.10).

Example 6

Constructing an angle of 45°

Solution

1. Construct an angle EAB of 90°.
2. Open a compass and taking B and F as centres, draw arcs intersecting at point G.
3. Join AG. Angle GAB is of 45° (Fig. 1.11).
4. Line AG is the bisector of 90° angle.

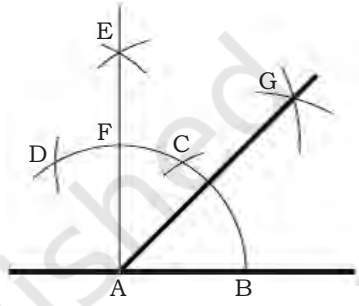


Fig. 1.11: Constructing an angle of 45°

Example 7

Draw a perpendicular line to the line AB at point A.

Solution

1. Using a scale draw a line AB. The perpendicular to this line is to be drawn at point A.
2. Set the compass to any radius and do not change it in further steps.
3. Draw an arc with A as centre, thus obtaining a point C on the line AB.
4. Draw an arc with C as centre, thus obtaining point D.
5. Draw an arc with D as centre, thus obtaining point E and it should also touch the line at point A.
6. Draw an arc with E as centre, thus obtaining point F.
7. The connecting line AF is the perpendicular line to line AB (Fig. 1.12).

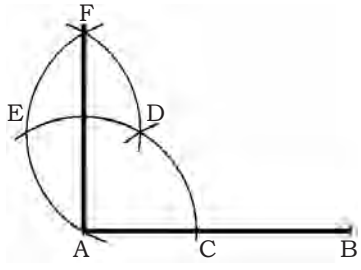


Fig. 1.12: Drawing a perpendicular to a given line

Example 8

Divide a given line into five equal parts

Solution

1. Using a scale draw a line AB. This line is to be divided into equal parts.

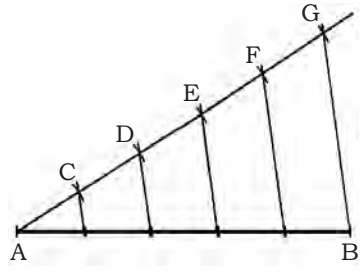


Fig. 1.13: Dividing a given line in equal parts

2. From point A of this line draw a second line at any convenient angle.
3. Open a compass to suitable length and divide the second line into 5 equal parts (points C–G) without altering the compass opening.
4. Connect G to B.
5. Using set squares draw parallel lines to GB from all the points (points F-C) as shown in Fig. 1.13.
6. Thus, the line AB gets divided into 5 equal parts.

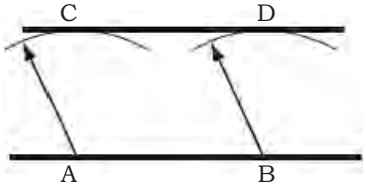


Fig. 1.14: Drawing parallel lines

Example 9

Drawing parallel lines with a compass

Solution

1. Using a scale draw a straight line AB and extend it to both sides.
2. Open the compass to a desirable length, place the compass needle at point A on the line and draw an arc as shown in the figure.
3. Do not alter the compass opening and draw a similar arc from point B on the line.
4. Mark the highest points on the arcs as C and D.
5. By using a scale, join points C and D and extend the line to both sides. The line CD thus obtained by joining the points is parallel to the line AB.
6. In case the parallel line is to be drawn, which passes through the point C, then draw a perpendicular from point C to the line meeting at A. Set the compass opening equal to the length of the perpendicular CA, draw an arc from the point B and mark highest point or point of tangency on the arc D and join CD. Alternatively, a perpendicular can be drawn from point B and cut this perpendicular at the same length as CA to obtain point D (Fig 1.14).

Triangle

A plane figure surrounded by three straight sides forms a triangle. A *scalene* triangle is formed by three unequal sides and three unequal angles. An *isosceles* triangle is a made by two equal sides, and hence two equal angles. An *equilateral* triangle is formed by all equal sides and equal angles. A *right-angled* triangle has only one right

angle in a triangle. The side opposite to the right angle is known as the 'hypotenuse'.

Example 10

Construct an equilateral triangle, if one of the sides is given.

Solution

1. Using a scale, draw a line AB equal to the given length of the side.
2. Place a compass needle at point A and open it to the radius equal to the length of side AB and draw an arc as shown in the Fig. 1.15.
3. Similarly, place the compass needle point on B, and without changing the radius, draw another arc to cut the first arc at point C.
4. Join AC and BC. Triangle ABC is an equilateral triangle in which AB–BC=CA.

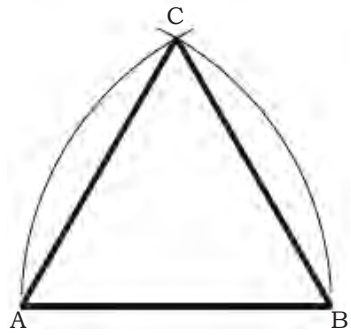


Fig. 1.15: Drawing an equilateral triangle

Example 11

Construct an isosceles triangle

Solution

1. Using a scale draw a line AB to a given length.
2. Open a compass more than the length of AB, place the compass needle at point A and draw an arc as shown in Fig. 1.16.
3. Keeping the same compass opening, again place the compass needle at point B and draw an arc, and intersect the previous arc at point C.
4. Join AC and BC.
5. ABC is the isosceles triangle in which AC=BC.

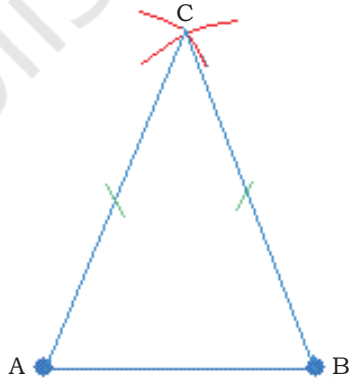


Fig. 1.16: Drawing an isosceles triangle

Example 12

Construct a scalene triangle with side lengths as 6cm, 5cm and 4cm, respectively

Solution

1. Using a scale draw a 6cm line. Mark one of the ends as 'A' and the other end 'B' as shown in the Fig. 1.17.
2. Set the compass to a radius of 5cm, which will be equal to the second side of the triangle.

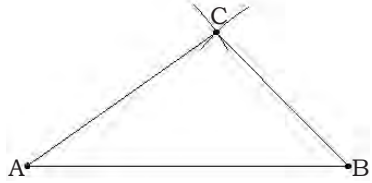


Fig. 1.17: Drawing a scalene triangle

3. Place the compass needle at point A and draw an arc above the line.
4. Set the compass to a radius of 4cm, which will be equal to the third side of the triangle.
5. Place the compass needle at point B and draw an arc above it so as to intersect the previous arc at point C.
6. Join AC and BC to form a scalene triangle ABC.

Quadrilateral

A figure bounded by four straight sides is called quadrilateral. The various types of quadrilaterals are as given below.

- A quadrilateral which has four sides of equal length and all the four angles as right angle is called square.
- A quadrilateral which has opposite sides of equal length and all the four angles as right angle is called rectangle.
- A quadrilateral which has opposite sides of equal length that are parallel is called parallelogram.
- A quadrilateral in which all four sides are equal is called rhombus.
- A quadrilateral with one pair of opposite sides as parallel is called trapezium.
- A quadrilateral in which all four sides and angles are unequal is called trapezoid.

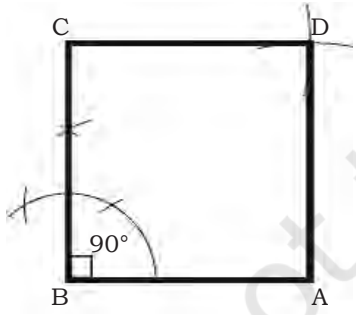


Fig. 1.18: Drawing a square

Example 13

Construct a square, when the length of the side is given

Solution

1. Using a scale draw the side BA equal to the given length.
2. Make an angle of 90° or erect a perpendicular from point B.
3. Mark the point C on the perpendicular line so that line BC is equal to the line BA in length.
4. Open the compass equal to the length of the side of the square, with needle point at A and C, draw arcs to intersect at point D.

5. Join CD and AD. Thus, the quadrilateral ABCD formed is the required square having all the sides equal and all the angles as right angles.

Example 14

Construct a square; the length of the diagonal given.

Solution

1. Using a scale draw a diagonal AC equal to a given length.
2. Bisect AC so that O is the midpoint of the diagonal. Extend the bisecting line.
3. Set the compass to radius OA (OC) and with the needle pointing at the centre O, draw a circle so as to cut the bisecting line at point B and D, respectively, as shown in Fig. 1.19.
4. With the help of a scale join the points on the circle and form the quadrilateral ABCD. Thus, the quadrilateral ABCD is the required square.

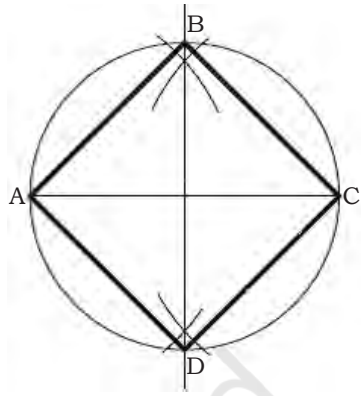


Fig. 1.19: Drawing a square

Example 15

Construct a parallelogram; length of two sides and an angle are given.

Solution

1. Using a scale draw AD equal to the length of one of the given sides.
2. With the help of a protractor construct the known angle at point A and extend the angle line.
3. Using compass or scale, mark off AB equal in length to the other given side.
4. Open the compass equal in radius to AD and with compass needle at point B draw an arc.
5. Open the compass equal in radius to AB and with compass needle at D, draw an arc equal in radius to AB, which intersects the previous arc at point C.
6. Join point B with C and point C with D. Thus, ABCD is the required parallelogram.

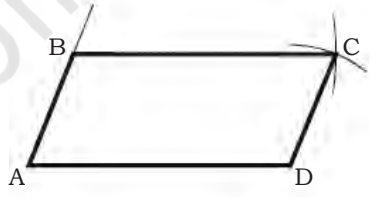


Fig. 1.20: Drawing a parallelogram

Example 16

Construct a trapezium, with given lengths of the parallel sides, the perpendicular distance between parallel and one angle.

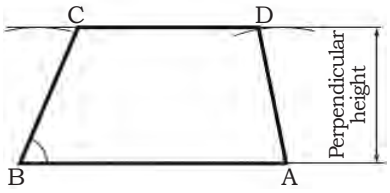


Fig. 1.21: Drawing a trapezium

Solution

1. Using a scale draw AB equal to the length of one of the parallel sides.
2. Open the compass equal to the given perpendicular distance, construct the parallel line by drawing arcs from point B and A, respectively.
3. From point B construct the given angle so as to intersect the parallel line in point C.
4. From point C mark off the other given length of parallel side equal to CD. Join DA.
5. Thus, ABCD is the required trapezium.

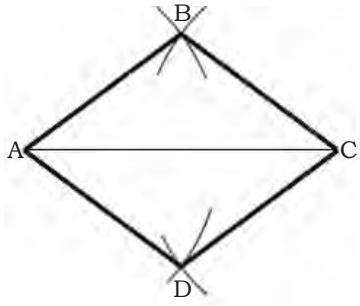


Fig. 1.22: Drawing a rhombus

Example 17

Construct a rhombus; the length of the diagonal and the sides are given.

Solution

1. Using a scale draw the line AC equal to the diagonal.
2. Open compass equal in length to the sides and from points A and C draw intersecting arcs, which intersect at points B and D, respectively.
3. Join AB, BC, CD, and DA.
4. Thus, ABCD is the desired trapezium.

Polygons

A plane figure bounded by more than four straight sides is called a polygon. If all sides of polygon are equal it is called a regular polygon. Therefore, all its exterior and interior angles of a regular polygon are equal.

The various types of polygons are as given below.

- A plane figure bounded by five sides is called pentagon.
- A plane figure bounded by six sides is called hexagon.
- A plane figure bounded by seven sides is called heptagon.
- A plane figure bounded by eight sides is called octagon.
- A plane figure bounded by nine sides is called nonagon.
- A plane figure bounded by ten sides is called decagon.

Example 18

Construct a regular hexagon; the length of the sides is given.

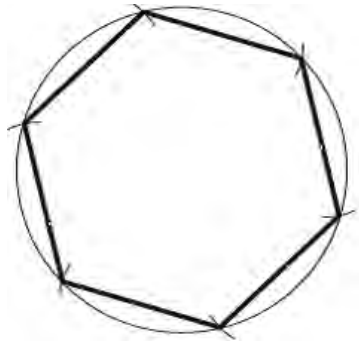


Fig. 1.23: Drawing a hexagon

Solution

1. Open the compass to a radius equal to the length of the side and draw a circle.
2. Do not change the opening of the compass, take any point on the circumference of the circle and mark the radius around the circle six times. You will finish exactly at the same point on the circumference where you started, if the construction is accurate.
3. Using a scale join the six points to form a regular hexagon as shown in Fig.1.23.

Example 19

Construct any regular polygon; the length of a side is given.

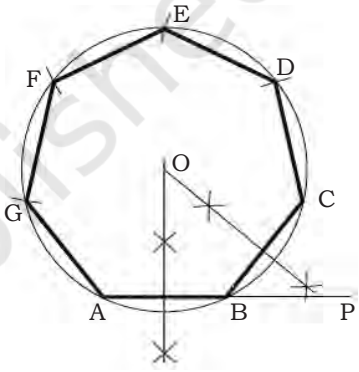


Fig. 1.24: Drawing a polygon

Solution: Method 1

1. Using a scale draw a line AB equal in length to one of the given sides. Extend the line AB to a point P.
2. The exterior angle of the polygon is calculated dividing 360° by the number of sides of the polygon. In this case the regular polygon is to heptagon, therefore, the exterior angle is 360°/7.
3. At point B draw the exterior angle PBC. Mark off BC equal to AB.
4. Bisect the lines AB and BC. The bisectors intersect at point O as shown in Fig.1.24.
5. Open the compass equal to radius OA (OB = OC) and with centre O draw a circle.
6. Mark off the sides of the figure with compass opening equal to the side of the polygon from C to D, D to E, E to F, and F to G.
7. Join the points on the circumference and ABCDEFG is the required heptagon.

Solution: Method 2

1. Using a scale draw a line AB equal in length to one of the given sides. Extend the line from the point A.

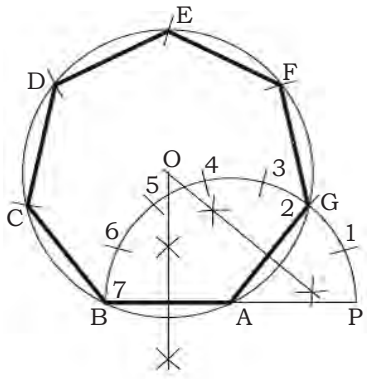


Fig. 1.25: Drawing a polygon

2. Open the compass equal to radius AB, with needle point at A draw a semi-circle so as to meet the extended line BA at point P.
3. Divide the semi-circle into equal parts. The number of parts should be equal to the number of sides of polygon. This may be done by calculation (180°/7 for each arc) since in the example the regular polygon is heptagon.
4. Using a scale draw a line from point A to point 2 (for all polygons). This line thus forms a second side of the polygon.
5. Using a compass, bisect the lines AB and A2 to intersect at point O as shown in Fig.1.25
6. Open the compass equal to radius OB (OA=O2) and with centre O draw a circle.
7. Mark off the sides of the figure with compass opening equal to the side of the polygon from B to C, C to D, D to E, E to F and F to G.
8. Join the points on the circumference and you have ABCDEFG as the required heptagon.

Solution: Method 3

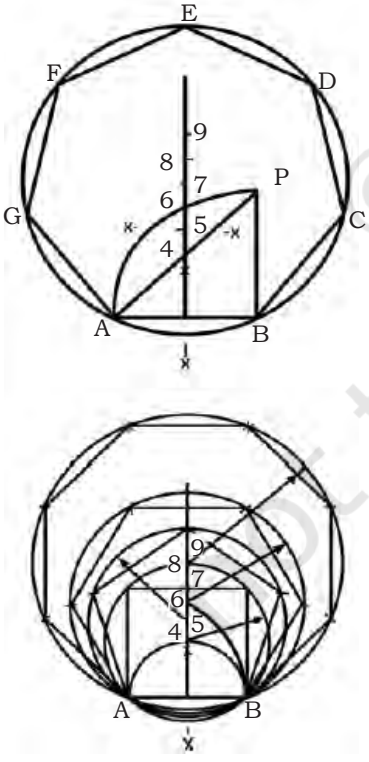


Fig. 1.26: Drawing a polygon

1. Using a scale draw a line AB equal to the given length of polygon.
2. At point B of the line, draw a perpendicular BP and mark it off equal to AB, the length of the side of polygon.
3. Join point A with point P to form straight line AP.
4. Open the compass equal to radius AB and with B as centre draw an arc AP.
5. Draw the perpendicular bisector on the line AB and extend it so as to meet the straight line AP and arc AP in points 4 and 6, respectively.
6. Using a compass bisect the distance between point 4 and 6 in order to get to point 5.
7. Adjust the compass to radii as 4B, 5B and 6B and draw circles with centres as point 4, 5 and 6 and inscribe a square, pentagon and hexagon in the respective circles.
8. For inscribing heptagon and octagon, and their respective circles, mark centre point 7, 8, with 6-7, 7-8 equal to the distance 4-5 as shown in Fig.1.26.

Practical Exercise

1. List four drawing instruments used for geometric constructions

S.No.	Instruments used
1.	
2.	
3.	
4.	

2. Draw any two drawing instruments (freehand sketches)

Check Your Progress

A. Fill in the blanks

1. The understanding of plane geometry is pre-requisite for the proper use of _____.
2. A plane figure surrounded by _____ forms a triangle.
3. A scalene triangle is formed by three _____ sides and three _____.
4. A figure bounded by _____ sides is called quadrilateral.
5. A quadrilateral with _____ sides is called *rhombus*.
6. A plane figure bounded by more than _____ sides is called a polygon.
7. A plane figure bounded by _____ sides is called a *heptagon.*
8. A plane figure bounded by _____ sides is called a *decagon.*

B. State whether the following statements are true or false

1. Bisecting the line means dividing the line into two equal parts.
2. If one line is perpendicular to another line, they intersect each other at 45°.
3. A triangle having all the three sides equal is called an equilateral triangle.
4. A plane figure with more than five sides is called a quadrilateral.
5. A quadrilateral with all four equal sides is called a rhombus.
6. A quadrilateral with one pair of opposite side parallel is called a trapezium.
7. A plane figure bounded by eight sides is called a *heptagon*.
8. A plane figure bounded by nine sides is called a nonagon.

C. Multiple choice questions

1. Which method is used for drawing various geometric shapes?
   (a) Geometric construction
   (b) Polygon method
   (c) Contour method
   (d) None of the above
2. An isosceles triangle has _____.
   (a) two equal sides and angles
   (b) two equal sides and angles
   (c) three equal sides and angles
   (d) None of the above
3. An equilateral triangle is formed by _____.
   (a) equal sides and equal angles
   (b) only equal sides
   (c) only angles
   (d) No equal side or angle
4. What is the sum of all three interior angles of a triangle equal to?
   (a) 180 degree
   (b) 90 degree
   (c) 360 degree
   (d) 60 degree

5. A figure bounded by four straight sides is called a _____.
   (a) quadrilateral
   (b) square
   (c) triangle
   (d) equilateral triangle

D. Answer the following questions

1. Why are geometric constructions important in making drawing?
2. What are the steps required for dividing a straight line into seven equal parts?
3. Differentiate between triangle and quadrilateral.
4. Differentiate between and quadrilateral and polygon.
5. List the steps for making polygon having 10 equal sides.
6. Draw tangents from a given point lying on the diameter of circle to the circle.

Session 2: Tools of Engineering Drawing

Engineering Drawing

A drawing is a graphical representation of a real object. An engineer expresses his ideas on a paper through the medium of drawing. The use of a drawing is to explain the shape and size of a particular object by means of lines. It also explains about the object, which cannot be expressed by lines given alongside the drawing in a concise manner. A good drawing gives detailed information about the object in a precise way.

For better understanding of a drawing, a person should know the standard conventions, basic symbols and rules used in the different types of drawings.

Drawing Scale

It is difficult to draw on paper the actual size of real-life objects, such as the real size of a car, an airplane, etc., we need scale drawings to represent the size like the one you see in Fig.1.27.

In real-life, the length of this van may measure 6000 mm. It is suggested that, the length of print paper that one may use to draw this van should be a little bit less than 300 mm.

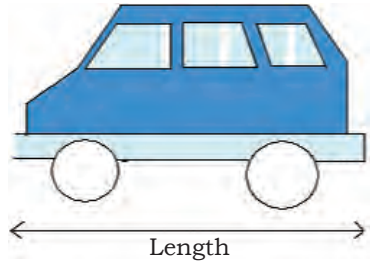


Fig. 1.27: Drawing scale

Since 6000/300 = 20, you will need about 20 sheets of copy paper to draw the length of the actual size of the van. In order to use just one sheet, you may use 1 mm on your drawing to represent 20 mm on the real-life object. We can write this situation as 1:20 or 1/20 or 1 to 20.

It may be noted that the first number always refers to the length of the drawing on paper, and the second number refers to the length of the actual object.

The drawing scale is also called representative fraction (RF). It shows instantly the ratio of the size of the line on the drawing and the actual size. It can be said that the ratio of the numerator to denominator of the fraction is the ratio of drawn size to natural size of an object. RF of 1/20 means that the actual size of the object is 20 times that of the size of the drawing of the same object.

The scale of 1:1 (read as one-to-one) shows that the object has been drawn to true size. A scale of say 2:1 (read as two-to-one) informs that the object has been enlarged twice its true size in the drawing. A scale of 1:2 (read as one-to-two) shows that the object has been reduced to its half size, etc.

Dimensions of Drawing Sheets

The common paper sizes for technical drawings are known as A-Formats. In the A-Format series, the largest size is A0. The size of an A1 paper is half the size of A0 while A2 is half the size of A1 and so forth. Higher order paper size (which is always smaller in size) is obtained by simply halving the preceding size along its longer side. Size of A4 is found to be the smallest paper size in technical drawings. The A format paper sizes are given below.

Designation	Dimensions in mm
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

Basic Line Types

The basis of any drawing is a line. The use of a right type of line helps make a correct drawing. The table given below shows some basic types and thickness of lines used for various purposes (for more lines refer to Bureau of Indian Standards). Each line represents a definite aim and it should not represent anything else.

Types of lines	Appearance	Name according to application
Continuous thick line		Visible line
Continuous thin line		Dimension line Extension line Leader line
Dash thick		Hidden line
Chain thin line		Centre line
Continuous thin wavy line		Short break lines or irregular boundary lines—drawn freehand
Continuous thin line with zig-zag		Long break lines
Short dashes gap 1, length 3 mm		Invisible or interior surfaces lines
Long chain, thick at end and thin elsewhere		Cutting plane lines

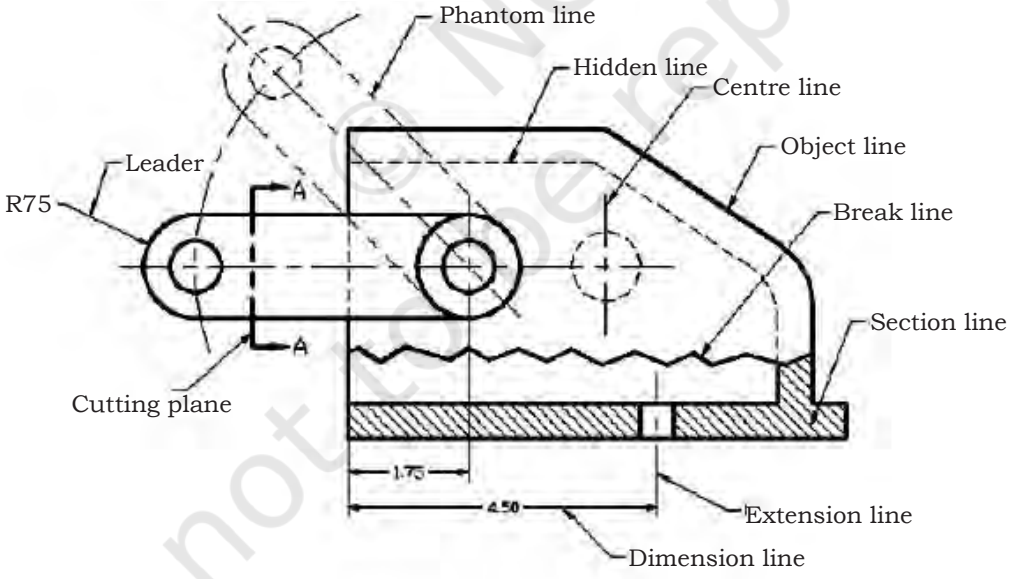


Fig. 1.28: Line conventions in engineering drawing

Meaning of lines

Visible or object lines represent features that can be seen in the current view.

Hidden lines explain the features which are not seen in the current view.

Center line explains symmetry, axis of symmetrical parts, centres of circles and path of motion.

Dimension, leader and extension lines show the sizes and location of items on a drawing.

Cutting plane lines explain the place of an unreal cut which has been done, so that the interior of the item can be seen.

Phantom lines indicate or show imaginary features, such as a moving position of a part.

Break lines explain imaginary cut where the interior of the object can be viewed.

Projections

A projection is view considered to be drawn onto a plane, called the plane of projection. Orthographic or multiview projection is made from an object developed by projectors from the object perpendicular to the planes of projection.

The concept of projection is used to display 3-D objects on 2-D media (paper, computer) graphically. The projection theory is based on line of sight and plane of projection.

Line of Sight

It is an imaginary line of light between an observer's eye and an object. There are two types of lines of sight: parallel and converge.

Isometric projection

In isometric projection, all dimensions with the three axes are drawn to true size. Isometric projection is made when the three views of the object are seen for accurate presentation of the object.

The main advantage of isometric drawing is that it is easy to understand and the disadvantage includes the distortion in shape and angles as shown in Fig.1.29.

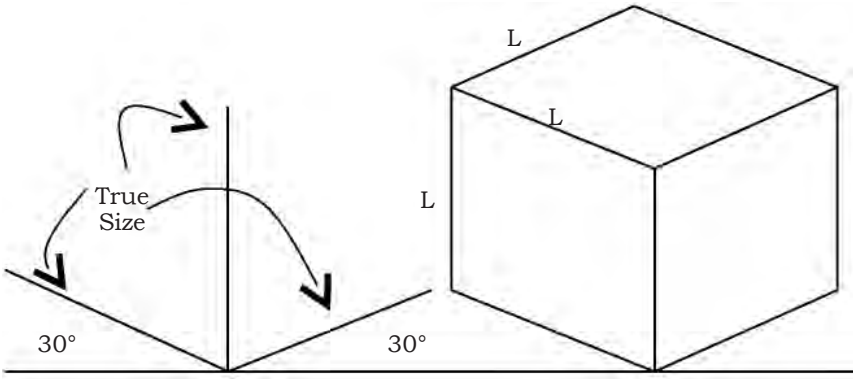


Fig. 1.29: Isometric projection

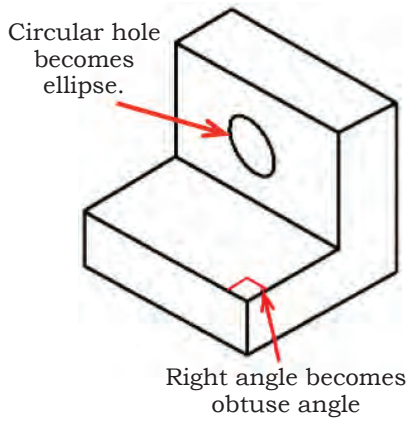


Fig. 1.30: Shape and angle distortion in isometric drawing

Orthographic projection

In this projection, an object is presented in a unique way where more views are required. It is a parallel projection technique in which the parallel lines of sight are drawn perpendicular to the projection plane as shown in Fig.1.31. The number of views needed should be sufficient to represent the object completely and conveniently, but it should be kept to the minimum. For all purposes, three views are completely sufficient.

- Engineering drawing usually prefer orthographic view rather than pictorial view.
- Orthographic view helps record the shape of an item accurately and completely.
- Orthographic view is a two-dimensional (2-D) drawing. It shows only one side of an object and two of its overall dimensions.
- A minimum of two orthographic views are required to show the three dimensions of any object and therefore to describe its shape completely.

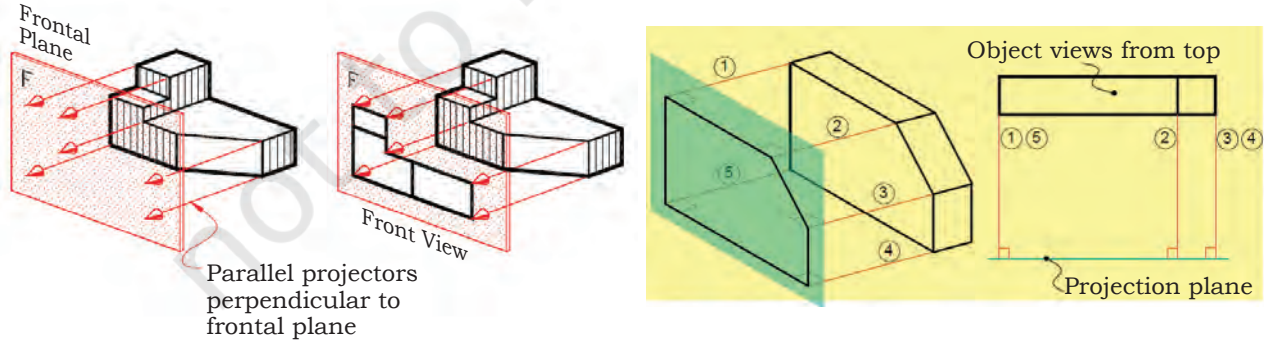


Fig. 1.31: Orthographic projection

Some features of the object that do not directly appear on viewing the object from any specific direction

(known as hidden details) are shown on the drawing as dotted lines.

Standard orthographic projections

Two standards are commonly in use in orthographic projection of drawings; the first angle projection and the third angle projection. It should be noted that corresponding views are identical in both methods of projection except for their relative positions on the drawing paper.

First Angle Projection

Here, the front view is the basis (reference) and the other views are drawn as 'shadows' of that view. That is, the left hand side view for instance is drawn on the right side of the front view. Similarly, the top view (plan) is drawn at the bottom of the front view, etc.

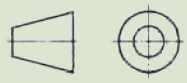
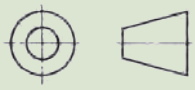
Projection	Symbol
First angle	
Third angle	

Fig. 1.32: Symbols used for first angle and third angle projections used in engineering drawing

Third Angle Projection

Here, the front view is the basis (just as before) but the other views are drawn as 'reflections' of that view. The left hand side view is drawn on the left hand side of the front view. Similarly, the top view (plan) is drawn at the top of the front view. The symbols for first and third angle projections are shown in Fig.1.32.

Example: First angle projection

In first angle projection, the item or object is kept in front of the image planes, and the views are created by projecting to the image plane situated at the back.

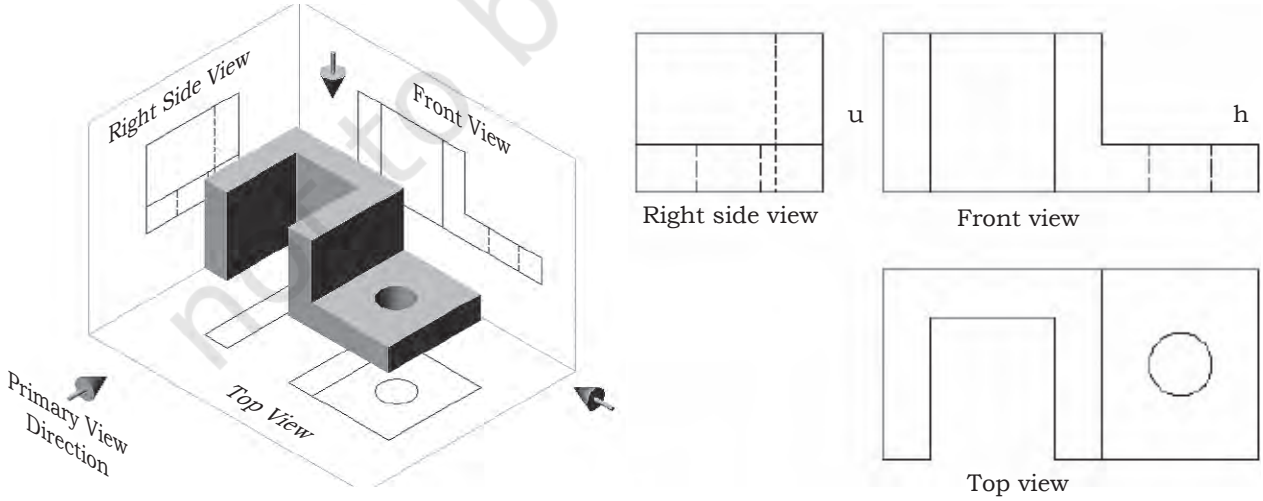


Fig. 1.33: First angle projection

Example: Third angle projection

In third angle projection, the image planes are kept in between the object and the observer. The views are created by projecting the image plane in front of the object.

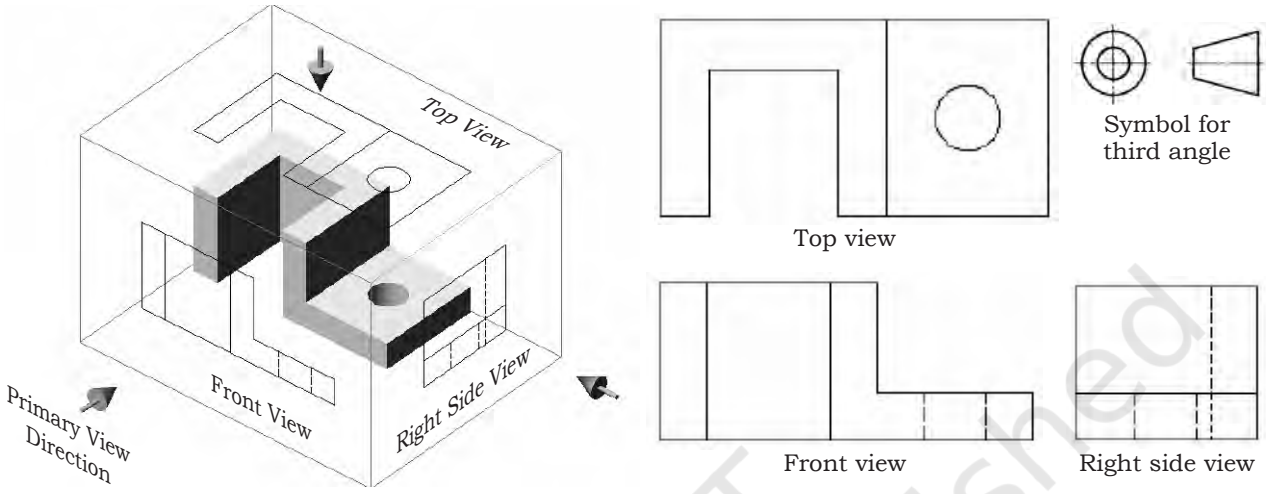


Fig. 1.34: Third angle projection

Dimensioning

For making of machine parts or components, all the relevant dimensions should be shown on the drawing. The practice is that any dimension is shown only once in that view in which it appears more explicitly. For this reason all the main dimensions are kept in the front view. Repetitions are avoided if not necessary. To keep the drawing clean, it is advised to put all the dimensions outside the drawing, except where and when this is unavoidable.

The dimensioning of the object of the isometric drawing is shown in Fig.1.35. As a thumb rule for dimensioning, make an object and dimension in the proper useful way. Dimensions should be drawn completely as per the needs of the draftsman or technician.

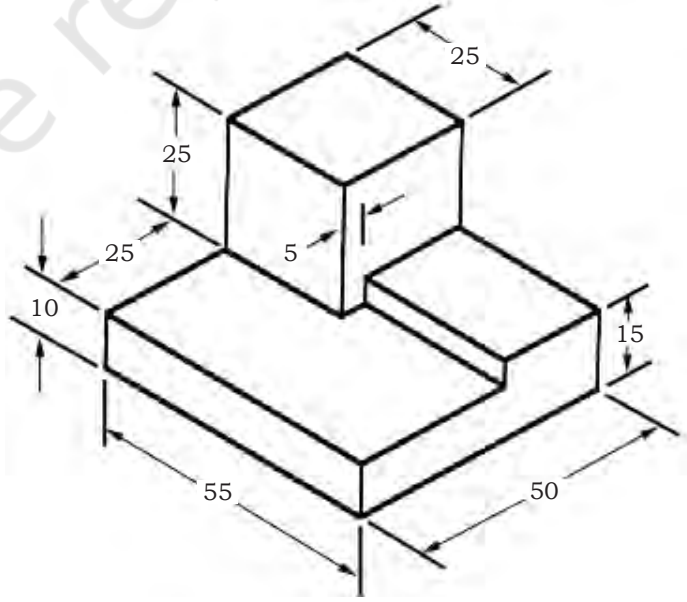


Fig. 1.35: Dimensioning of an object

Repeatedly measuring from one point to another point may lead to inaccuracies. It is always appropriate to measure dimensions from one end to other end. It is useful to choose the placement of the dimension in order so that mechanist would develop the part of product easily.

General Hints on Dimensioning

- Use common sense as per need and depend on circumstances.
- All linear dimensions are considered to be in millimetre in metric system.
- Show full size dimensions regardless of the scale used in the drawing.
- Dimension in a manner that makes it unnecessary to calculate any required size information.

Fig: 1.36 shows dimensioning of a 2-dimensional drawing.

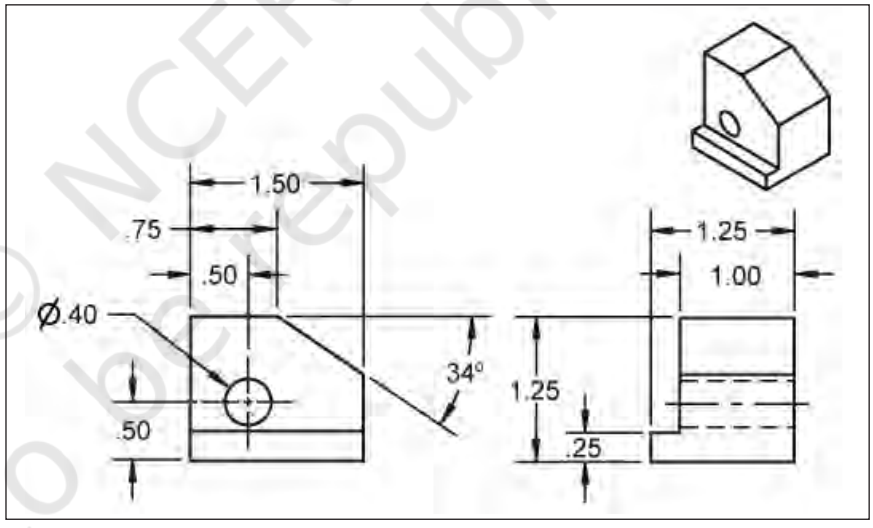


Fig. 1.36: Dimensioning of a 2-dimensional drawing

Drawing Sheet Layout

Standard layouts of drawing sheets are specified by various standard organisations. Fig.1.37 shows the layout of a specific drawing sheet, showing the drawing frame with a title block, parts list and space for orthographic projections.

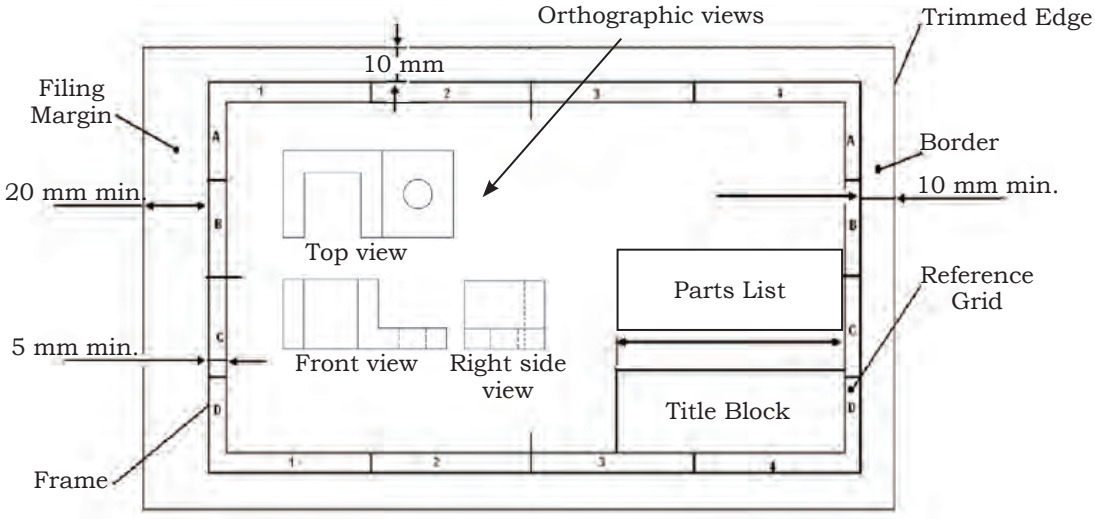


Fig. 1.37: Layout of a drawing sheet

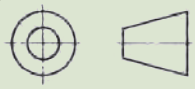
Title Block

In an engineering drawing the Title Block is shown at the bottom right-hand corner.

The title block is written in a simple way for better understanding. The following information should be added in this box:

- Name of the firm/school/college
- Name of the object (work piece)
- Number of the drawing
- Format of the paper used (paper size)
- Scale used
- Dimensioning unit [usually millimetres (mm)]

The format of a title block may vary. A typical title block is shown below.

Projection: 	Scale: 1:10	Drawn: Kashiv	Remarks:	
	Dimension:	Group: Eng. & Tech		
	Date:	Checked: Saurabh		
PSSCIVE Bhopal	Name of Object: Knuckle Joint		Drg. No.	Format

Parts List

It is an essential component in any assembly drawing. It is generally drawn above the title block. Width of parts list is the same as the title block, i.e. 180-mm.

The height depends on the number of items to be included. The following information is usually included in the Parts List:

A—Part reference number
B—Name of the part
C—Number of parts required in an assembly
D—Material used to manufacture the part
E—Indication of standard or dimension
F—Drawing number

A	B	C	D	E	F
Ref. No.	Name of part	No. Reqd.	Material	Standard/Dimension	Drg. No.

Spacing of views

Spacing of views on the drawing sheet is extremely important. All the views should be placed systematically. Spacing of views on the drawing sheet should be done in such a way that the spaces between the views and the limits of the drawing space are roughly equal (horizontally and vertically).

Steps

1. Decide on the views to be drawn (i.e., front view, left-hand side view and top view).
2. Determine the maximum dimensions of the various views to be drawn.

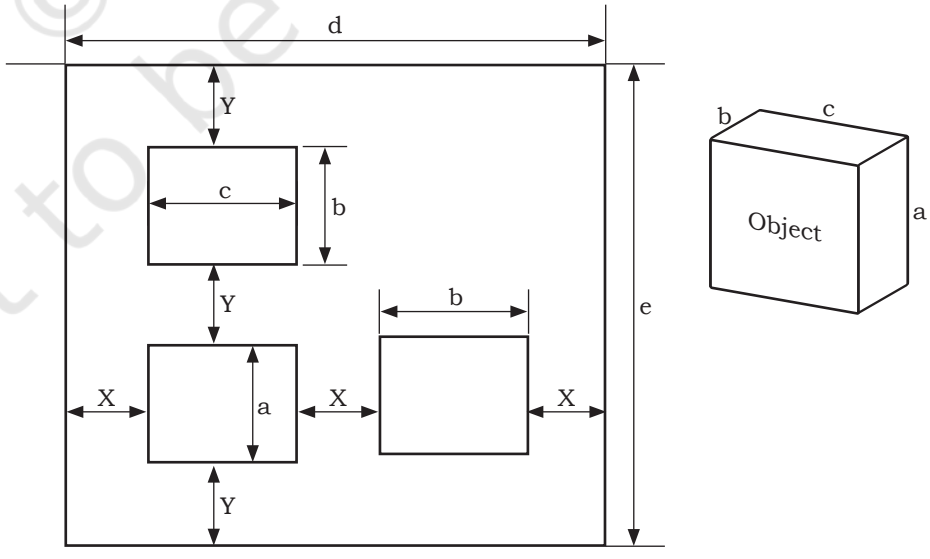


Fig. 1.38: Spacing of views

3. Determine the required space, based on the scale to be used, both along the horizontal and vertical directions.
4. Divide the 'free space' into three equal portions, both horizontally and vertically. This determines X and Y as shown in the Fig. 1.38.

Horizontal Free Space = (Horizontal Drawing Space) – (Occupied Space) = d – (c + b)

Horizontal spacing (X) = (Horizontal Free Space)/ (Number of Spaces) = {d – (c + b)}/3

Vertical Free Space = (Vertical Drawing Space) – (Occupied Space) = e – (a + b)

Vertical spacing (Y) = (Vertical Free Space)/ (Number of Spaces) = {e – (a + b)}/3

Reading Drawings

Technical drawings are used to visualise the product or component to be manufactured, built or assembled. A technical drawing explains shapes, dimensions, and material of construction and final shape of the material being created. For reading and understanding a drawing, it is important to understand how engineers or draughtsmen use dimensions, lines and notes to communicate the ideas on a sheet. Drawings should be seen as a form of communication. They are imagined or drawn to help one understand all the necessary information required to make and assemble an object regardless of the complexity. It is important that a person is able to read the drawings.

1. Firstly, ensure the right drawing is being read, check the name and part number of the drawing.
2. Look at the Title Block on the drawing, which is given on the lower right hand side of the drawing. The Title Block contains the information about the name of the person who has drawn it, checked it, name of the firm or institute, drawing number, part number, projection angle and the scale of the drawing. This will help you to know the component's information.
3. Fig.1.28 (refer to line section) shows the different types of lines that are used in drawings. Each line has a specific meaning and it must be understood to interpret a drawing correctly.

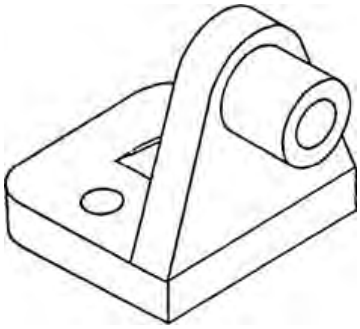


Fig. 1.39: Pictorial view

4. Look at Fig.1.39. It shows a pictorial drawing. These drawings are frequently used to show how an object should appear after it is manufactured. Pictorial drawings are used for simple objects.
5. For a more critical object, as shown in Fig.1.42, it becomes difficult to give the complete description in a pictorial drawing. In this case, it is a common practice to prepare orthographic drawings. These drawings are prepared to describe the object completely.

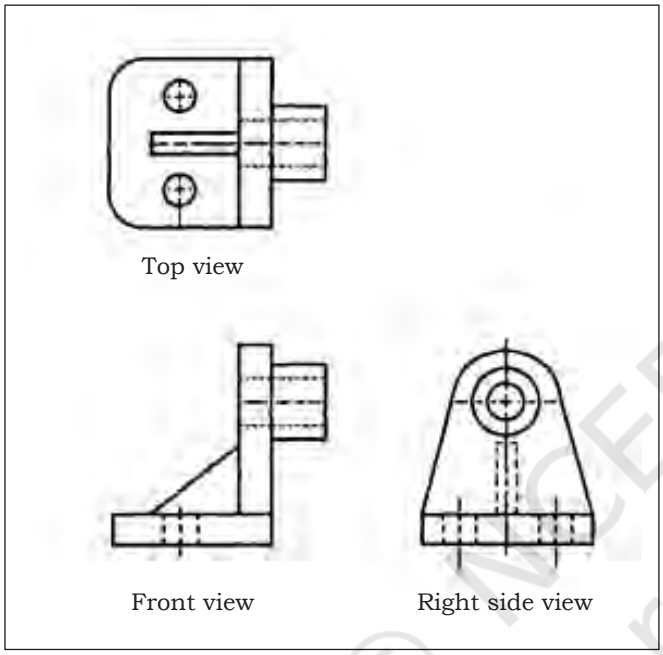


Fig. 1.40: Orthographic views

6. Orthographic drawings are made by parallel projections and include 2-dimensional multiview drawings of the object. These consist of a front view, top view and side view. Usually three views are sufficient to describe the project. However, any complex product may require as many as six views (top, front, left side, right side, back, and bottom).
7. Check the places of the views shown in Fig.1.40. As per practice, the top view is placed above the front view and the right side view is placed to the right of the front view. If additional views are needed, the left side is always drawn to the left of the front view and the bottom is drawn below the front view. Placement of the back view is flexible; it is usually drawn to the left of the left side view. When understanding the different orthographic views, a pictorial sketch should be prepared.
8. In the drawing of dimensions the width and height of the object can be seen in the front view. The drawing of the top shows width and depth, and the side shows height and width.
9. Section views show the hidden features of an object so that a workshop technician can completely understand the inside and outside details.
10. The dimensions provided in and around the projection views indicate measurements and

the complete size. Usually there are two types of lines—projection and dimension.

11. Projections lines are made or drawn in alignment with edges of the object. Projection lines are used to show the width of the indicated section.
12. Dimension lines are drawn from one projection line to another, with arrowheads touching each projection line. Measurements are written on dimension lines to describe the size.
13. Look at symbols on the drawing. Identify the ones that are important when learning about measurement.
14. Special precaution should be taken while handling the drawings. When drawings are not being used, store them in a place assigned for storage. Drawings are important items and are difficult to replace if lost or damaged.

Practical Exercise

1. Make a list of drawing instruments used for geometric constructions

S.No.	Instruments used

2. Draw the layout of a drawing sheet.

3. Draw and label the six orthographic views of an object.

Check Your Progress

A. Fill in the blanks

1. A drawing is a _____ representation of a real object.
2. Engineering drawings do not portray the objects the way they _____ to the eye.
3. The scale of 1:1 implies the object has been drawn to _____ size.
4. Hidden lines represent features that cannot be seen in the _____ view.
5. In an isometric projection, all dimensions along all the _____ are drawn to _____ size.

B. State whether the following statement are true or false.

1. A4 paper size has dimensions of 297 × 420 mm.
2. Break lines are used to represent an imaginary cut, so that the interior of the object can be viewed.
3. A scale of say 2:1 implies that the object has been enlarged twice its true size.
4. In diametric projection, all dimensions with two axes are drawn to true size.
5. In an isometric projection, all dimensions along all the three axes are not drawn to true size.
6. Orthographic views help to record the shapes of objects accurately and completely.
7. A nonagon is a plane figure bounded by nine sides.
8. In the First Angle Projection the front view is the basis (reference) and the other views are drawn as 'shadows' of that view.
9. In every engineering drawing, a Title Block is included at the bottom right-hand corner.
10. Spacing of views on the drawing paper is not important.

C. Multiple choice questions

1. A drawing is a graphical representation of a _____.
   (a) real object
   (b) mirror object
   (c) projection
   (d) None of the above

2. The drawing scale is also called _____.
   (a) representative fraction (RF)
   (b) projection factor
   (c) geometric fraction
   (d) None of the above
3. The common paper sizes for technical drawings are known as _____
   (a) A-Formats
   (b) B-Formats
   (c) A0-Formats
   (d) A2-Formats
4. Which lines show imaginary features, such as a moving position of a part?
   (a) Phantom lines
   (b) Break lines
   (c) Hidden lines
   (d) Centre line
5. Which line explains symmetry, axis of symmetrical parts, centres of circles and path of motion?
   (a) Center line
   (b) Break lines
   (c) Hidden lines
   (d) Hidden lines

D. Answer the following questions

1. Why are engineering drawings important in manufacturing and assembly?
2. What are the steps required for making an engineering drawing?
3. What is the importance of scale in making an engineering drawing?
4. List the differences between diametric and isometric projection.
5. Give the different formats of paper sizes used in making engineering drawing.
6. Write down the steps for reading engineering drawing.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-1 SESSION-1

A. Fill in the blanks

1. The understanding of plane geometry is pre-requisite for the proper use of _____.
2. A plane figure surrounded by _____ forms a triangle.
3. A scalene triangle is formed by three _____ sides and three _____.
4. A figure bounded by _____ sides is called quadrilateral.
5. A quadrilateral with _____ sides is called *rhombus.*
6. A plane figure bounded by more than _____ sides is called a polygon.
7. A plane figure bounded by _____ sides is called a *heptagon.*
8. A plane figure bounded by _____ sides is called a *decagon.*

B. State whether the following statements are true or false

1. Bisecting the line means dividing the line into two equal parts.
2. If one line is perpendicular to another line, they intersect each other at 45°.
3. A triangle having all the three sides equal is called an equilateral triangle.
4. A plane figure with more than five sides is called a quadrilateral.
5. A quadrilateral with all four equal sides is called a rhombus.
6. A quadrilateral with one pair of opposite side parallel is called a trapezium.
7. A plane figure bounded by eight sides is called a *heptagon.*
8. A plane figure bounded by nine sides is called a nonagon.

C. Multiple choice questions

1. Which method is used for drawing various geometric shapes?
   (a) Geometric construction
   (b) Polygon method
   (c) Contour method
   (d) None of the above
2. An isosceles triangle has _____.
   (a) two equal sides and angles
   (b) two equal sides and angles
   (c) three equal sides and angles
   (d) None of the above
3. An equilateral triangle is formed by _____.
   (a) equal sides and equal angles
   (b) only equal sides
   (c) only angles
   (d) No equal side or angle
4. What is the sum of all three interior angles of a triangle equal to?
   (a) 180 degree
   (b) 90 degree
   (c) 360 degree
   (d) 60 degree
5. A figure bounded by four straight sides is called a _____.
   (a) quadrilateral
   (b) square
   (c) triangle
   (d) equilateral triangle

D. Answer the following questions

1. Why are geometric constructions important in making drawing?
2. What are the steps required for dividing a straight line into seven equal parts?
3. Differentiate between triangle and quadrilateral.
4. Differentiate between and quadrilateral and polygon.
5. List the steps for making polygon having 10 equal sides.
6. Draw tangents from a given point lying on the diameter of circle to the circle.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-1 SESSION-2

A. Fill in the blanks

1. A drawing is a _____ representation of a real object.
2. Engineering drawings do not portray the objects the way they _____ to the eye.
3. The scale of 1:1 implies the object has been drawn to _____ size.
4. Hidden lines represent features that cannot be seen in the _____ view.
5. In an isometric projection, all dimensions along all the _____ are drawn to _____ size.

B. State whether the following statement are true or false.

1. A4 paper size has dimensions of 297 × 420 mm.
2. Break lines are used to represent an imaginary cut, so that the interior of the object can be viewed.
3. A scale of say 2:1 implies that the object has been enlarged twice its true size.
4. In diametric projection, all dimensions with two axes are drawn to true size.
5. In an isometric projection, all dimensions along all the three axes are not drawn to true size.
6. Orthographic views help to record the shapes of objects accurately and completely.
7. A nonagon is a plane figure bounded by nine sides.
8. In the First Angle Projection the front view is the basis (reference) and the other views are drawn as 'shadows' of that view.
9. In every engineering drawing, a Title Block is included at the bottom right-hand corner.
10. Spacing of views on the drawing paper is not important.

C. Multiple choice questions

1. A drawing is a graphical representation of a _____.
   (a) real object
   (b) mirror object
   (c) projection
   (d) None of the above

2. The drawing scale is also called _____.
   (a) representative fraction (RF)
   (b) projection factor
   (c) geometric fraction
   (d) None of the above
3. The common paper sizes for technical drawings are known as _____
   (a) A-Formats
   (b) B-Formats
   (c) A0-Formats
   (d) A2-Formats
4. Which lines show imaginary features, such as a moving position of a part?
   (a) Phantom lines
   (b) Break lines
   (c) Hidden lines
   (d) Centre line
5. Which line explains symmetry, axis of symmetrical parts, centres of circles and path of motion?
   (a) Center line
   (b) Break lines
   (c) Hidden lines
   (d) Hidden lines

D. Answer the following questions

1. Why are engineering drawings important in manufacturing and assembly?
2. What are the steps required for making an engineering drawing?
3. What is the importance of scale in making an engineering drawing?
4. List the differences between diametric and isometric projection.
5. Give the different formats of paper sizes used in making engineering drawing.
6. Write down the steps for reading engineering drawing.

Unit 2

Fasteners

As you already know, an automobile is an assembly of a large number of sub-assemblies and components, such as engine, clutch, gearbox, differential wheels brakes, etc. Automotive fasteners are a collection of products that are used in automotive and vehicle assembly for joining these components. Each of these assemblies is formed by joining many components. Some of the components or sub-assemblies may move together (kinematic joint), some are physically fixed together, with zero motion possible (rigid joint). Both types of joints are important in manufacturing a vehicle. The process and methods used for joining depend on the type of joint, the required strength, the material of the components being joined, the geometry of the components, and cost. The five most common methods used for joining are:

1. Mechanical fastening
   - Screws
   - Bolts
   - Nuts
   - Rivets
2. Welding
3. Brazing

4. Soldering
5. Adhesive bonding

Mechanical Fasteners

A mechanical fastener is a device that is used to mechanically join (fasten) two or more objects together and the process is called fastening. Bolts, nuts, screw, stud, rivets, shins, pin, tie rods, etc., are some examples of mechanical fasteners.

Mechanical fasteners are usually made of stainless steel, iron, brass, aluminium, nickel, etc.

Fig. 2.1: Fasteners

In general, fasteners are used to create non-permanent joints; that is, joints that can be removed or dismantled without damaging the joining components. The main components of engine are joined by fasteners. Similarly, there are many other sub-assemblies, which are joined by the fasteners to make an engine.

Session 1: Automotive Bolts and Machine Screws

Automotive bolts and machine screws are also known as threaded fasteners. They are effective at joining multiple objects. Fasteners have a threaded pin or rod with a head at one end. An automotive bolt is inserted through holes in the assembled parts and fixed firmly with a mated nut with the help of a torque. The bolt and nut are tightened by holding the bolt head stationary and turning the nut for tightening.

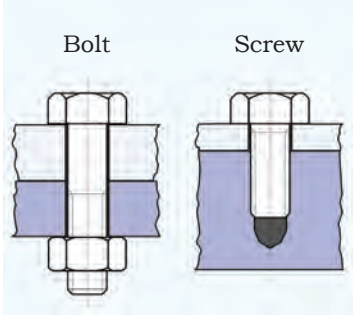


Fig. 2.2: Bolt and screw

Whereas, a machine screw is an outside threaded fastener. On the top of a screw is a head, which is used to drive the screw into the object. An automotive bolt with a common head can work as a screw, and can be driven into a hole by the head (Fig.2.2). Usually, the machine screws are fully threaded.

There are many types of automotive bolts, such as connecting rod bolts, wheel bolts, hub bolts, U-bolts, J-bolts, engine mounting bolts, suspension links and

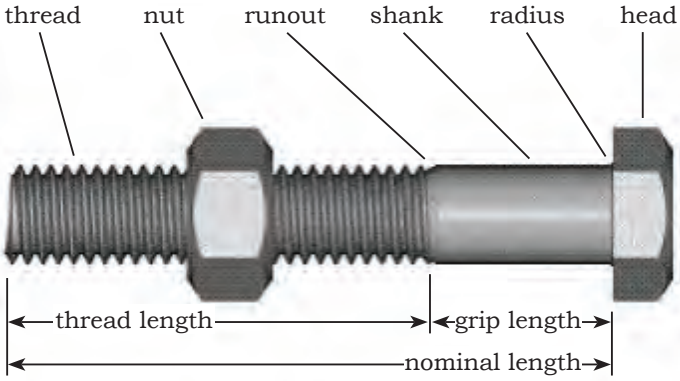


Fig. 2.3: Parts of standard bolt

bolts, lug bolts, radiator bolts, motor mount bolts, all mounting plates bolts, etc. The parts of a standard bolt are shown in Fig.2.3. A bolt is measured either in Inch or Metric. A screw and bolt are defined by length, type of head and the thread.

Thread on the Bolt

A bolt thread is a ridge of uniform section in the form of a helix on either the external or internal surface of the cylinder. Internal threads refer to those on nuts and tapped holes and external threads are those on bolts, studs or screws. The helix of a thread can twist in two possible directions—right hand (RH) or left hand (LH) (Fig. 2.4). The number of screw threads may vary from 2 to 20 starts or more. As illustrated in Fig.2.5, if the end view is an offset circle, then the screw is a single start.

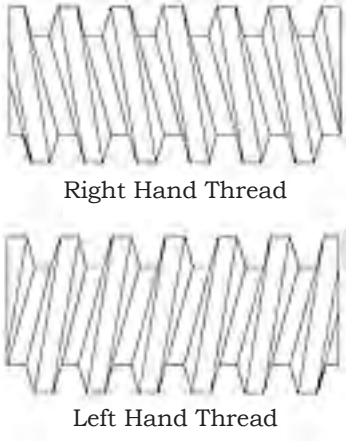


Fig. 2.4: Threads on the bolt

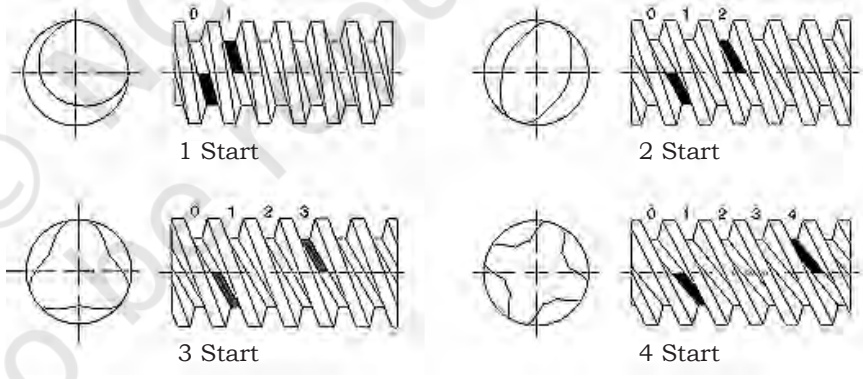


Fig. 2.5: Number of starts

Basic Thread Terms

The basic parts of thread as shown in Fig.2.6 have been explained below:

Pitch Diameter

It is the effective diameter of a screw thread, approximately halfway between the major and minor diameters.

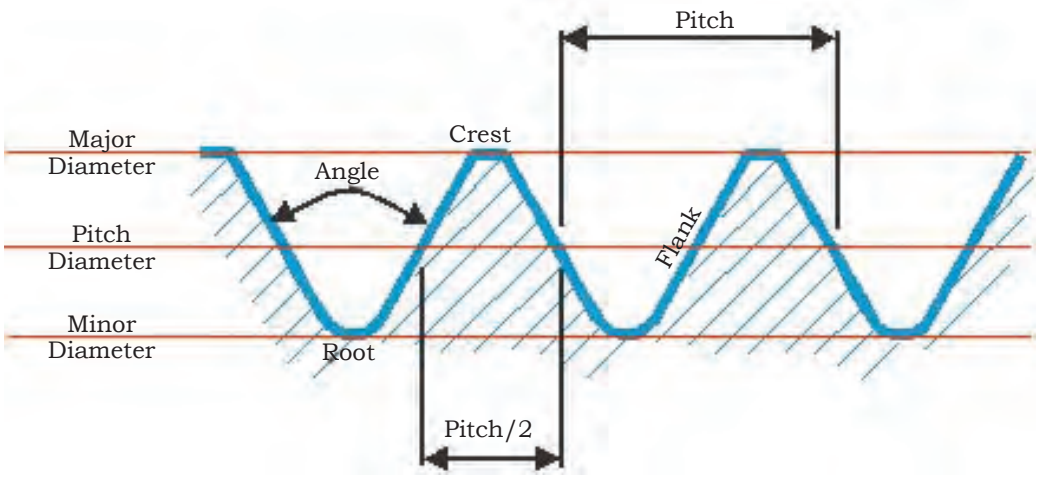


Fig. 2.6: Basic parts of thread

Major Diameter

It is the largest diameter of a screw thread measured at the crest of a male thread and at the root of a female thread.

Minor Diameter

It is the smallest material diameter of a thread.

Crest

It is the major part of a thread internally or externally.

Flanks

They are the straight sides which connect the crest and the root of the thread.

Root

The root is the bottom of the groove between the two flanking surfaces of the thread whether internal or external.

Thread Angle

It is the angle between the flanks.

Pitch

It is the distance between corresponding points on adjacent surface of the thread, in the same axial plane.

Basic Profile of Metric Thread

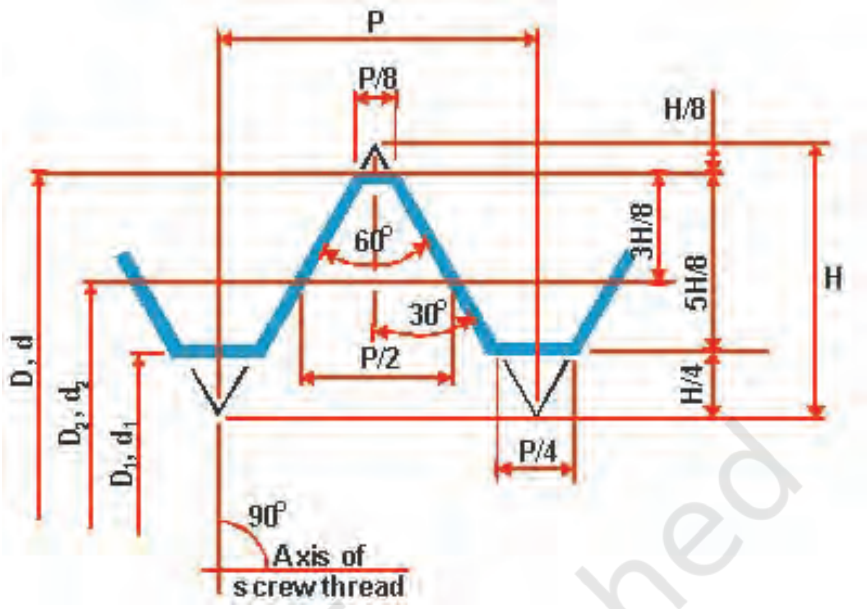


Fig. 2.7: Basic profile of ISO metric thread

In India, we use ISO metric threads and their basic profile is shown in Fig.2.7, where

D= Major diameter of internal thread (nut)

d= Major diameter of external thread (bolt)

D_2= Pitch diameter of internal thread

d_2= Pitch diameter of external thread

D_1= Minor diameter of internal thread

d_1= Minor diameter of external thread

P= Pitch

H= Height of fundamental triangle

d = D = nominal diameter

d1 = D1 = d - 1.0825 P

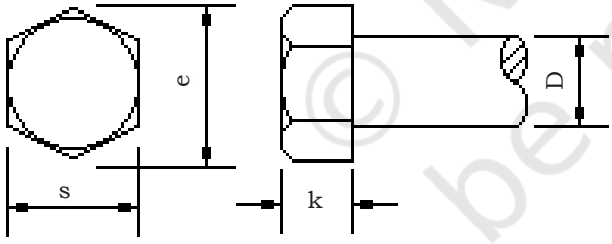
d2 = D2 = d - 0.6495 P

P = Pitch

H = 0.866 P

r = 0.1443 P

Hexagonal Bolt



Non-structural	Structural
e = 1.6 D	s = 1.8 D
e = 1.8 D	e = 2 D
k = 0.7 D	k = 0.7 D

ISO metric bolts

Fig. 2.8: Bolt head dimensions

Bolt Head Dimensions

Bolt head dimensions are related to their diameter as follows (Fig.2.8):

Structural Bolts

A large, heavy-duty hex bolt designed for steel-to-steel structural connections. They are used for structural

applications in buildings and bridges, ships, airplanes and vehicles. Consequently, they are typically very short.

Non-structural Bolts

These are general duty hex bolts used in sheet metal works and for fixing trims in vehicles.

Bolt Head Marking

The lines on the head of a bolt indicate its grade. Bolt head markings for metric bolts have been given in the table below.

Head Marking	Class and Material	Nominal Size Range (mm)	Mechanical Properties		
			Proof Load (MPa)	Min. Yield Strength (MPa)	Min. Tensile Strength (MPa)
 8.8	**Class 8.8** Medium Carbon Steel, Quenched and Tempered	All Sizes below 16mm	580	640	800
		16mm – 72mm	600	660	830
 10.9	**Class 10.9** Alloy Steel, Quenched and Tempered	5mm – 100mm	830	940	1040
 12.9	**Class 12.9** Alloy Steel, Quenched and Tempered	1.6mm – 100mm	970	1100	1220
Stainless markings vary. Most stainless is non-magnetic. Usually stamped A-2	**A-2 Stainless** Steel alloy with 17–19% Chromium and 8–13% Nickel	All sizes 20mm		210 Min. 450 Typical	500 Min. 700 Typical

Tensile Strength: The maximum load in tension (pulling apart) which a material can withstand before breaking or fracturing.
Yield Strength: The load at which a material shows a specific deformation.
Proof Load: Load at which the product withstand without evidence of any permanent set.
1MPa = 1N/mm^2 = 145 pounds/inch^2

Bolt and Machine Screw Material

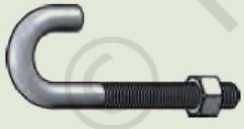
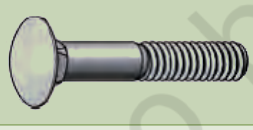
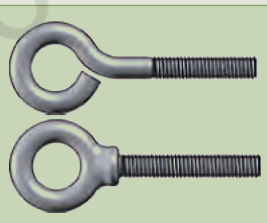
Bolt and machine screw material can be important when choosing a fastener due to its features.

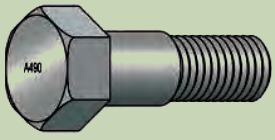
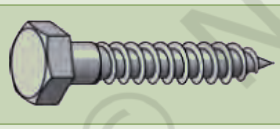
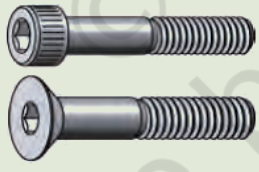
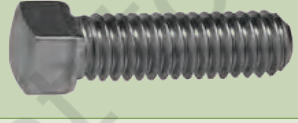
Some of the material used to make these have been given in the Table below.

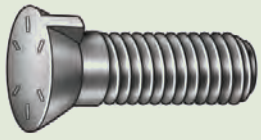
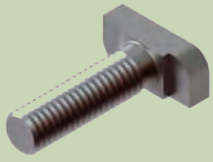
Material	Features
Aluminium	Lightweight, resistant to oxidation, easy to manufacture and thermal and electrical conductive.
Brass	Strong, conductive and corrosion resistant
Copper alloy	Higher load-carrying capacity, wear resistant
Plastic	Inexpensive and corrosion resistant (for light loads)
Steel	Strong, carbonated iron
Hardened steel	Stronger than steel screws, but brittle
Stainless steel	Chemical and corrosion resistant with an appealing finish
Super alloys	Heavy mechanical strength, surface stability, corrosion resistant and creep to resistant at high temperatures
Titanium	Hard and strong, light weight and corrosion resistant

Types of Bolts

The table given below lists the different types of bolts and their features.

Type	Shape	Features
Anchor bolt		Available in roll as well as cut thread and is 'J' shaped.
Carriage bolt		It is a threaded fastener used with wood. It comes in an assortment of lengths, diameters and thread pitches.
Elevator bolt		Fastener used with wood, although it is used to fasten metal components
Eye bolt		It is a screw with a loop on one end and thread on the other. Eye bolts are used to attach cables to objects.

Flange bolt		They are also known as frame bolts, hex frame flange bolts and hex flange screws.
Frame bolt		It is a one-piece hex-washer head bolt with a flat bearing surface made of high alloy steel. It is used in truck frames.
Hanger bolt		They are threaded at both ends. Standard hanger bolts are designed for insertion in a predrilled pilot hole.
Heavy hex bolt		A low carbon steel hex head bolt with a wider head than that of a standard hex bolt.
Hex bolt		These bolds have a hexagonal head. They are available in different grades of stainless steel, brass, silicon, bronze, etc.
Hex machine bolt		These bolts have a hexagonal head on one end, no washer face on the bearing surface and a threaded shaft on the other end
Socket shoulder bolt		It is hex socket head screw with an enlarged, unthreaded and cylindrical shoulder under the head.
Lag bolt		It is a full-bodied bolt with a hex head. It used for wood applications, such as in fences, patio covers, etc.
Socket screws		A hex socket head screw with an enlarged, unthreaded, cylindrical shoulder under the head for use as a bearing pin. Allen head wrench is used for tightening the screw.
Square headed bolt		They are similar to hex cap screw in size and shape but the head is square instead of hexagonal. They have the roll thread and also come in the lag screw thread as well.
U-bolt		It is a 'U' shaped bolt with two threaded arms. U-bolts are used as framing fasteners for foundations and pipe and conduit holders.

Knurled bolts		This type of bolt is used in electrical switchboards.
Plough bolt		It is used for making mechanical connections that require a smooth, or flush, surface. It is used in many heavy construction equipment, such as snowplows, road graders and scoop shovels.
T-head bolt		It is a bolt with a T-shaped head that matches T-slots in a machine table. It is used for holding parts on a machine table.

Machine Screws

Machine screws have threads for use with a nut or in a tapped hole. Also referred to as a stove bolt. The dimensions of metric machine screws are as shown below.

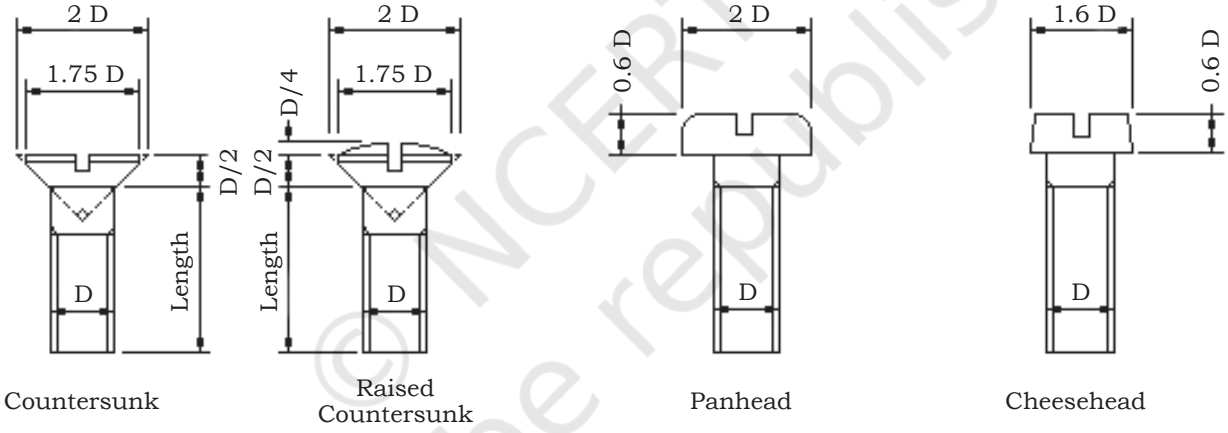
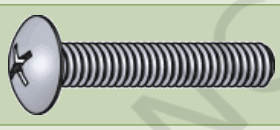
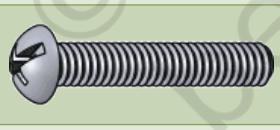
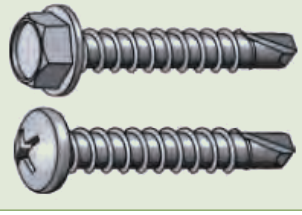


Fig. 2.9: ISO metric machine screws

Different types of machine screws categorised on the bases of head shape and features have been given in the table below.

Type	Head Shape	Features
Phillips pan head		It is slightly rounded with short vertical sides and the head is 'X' shaped to fit into a phillips screwdriver.
Slotted flat head		Its head has a flat top. It has a simple slot for a flat bladed screwdriver.

Slotted oval head		It is countersunk with a rounded top.
Slotted truss head		It is wide with a low profile rounded top.
Slotted round head		Slotted drives have simple slots for a flat bladed screwdriver.
Torx pan head type F		It is slightly rounded with short vertical sides. Torx drives are designed for maximum installation torque.
Slotted hex washer head type F		Slotted hex washer heads are six sided for use with a wrench.
Phillips flat head		Flat heads are countersunk with a flat. It is X shaped for a Phillips screwdriver.
Phillips oval head		Phillips drives are X shaped for a Phillips screwdriver.
Phillips truss head		It is wide with a low profile rounded top.
Combo truss head		It is wide with a low profile rounded top.
Combo round head		It is domed and looks like half of a sphere.
Torx flat head type F		Type F screws have a thread cutting tip.
Set screw		These screws have no head for screwing.
Sheet metal screw		It is a screw with a self drilling point.

Practical Exercise

1. List the different types of bolts used in a vehicle and state their features.

S.No.	Type of bolt	Features
1.		
2.		
3.		
4.		

2. List the types of machine screws used in a vehicle and state their features.

S.No.	Type of bolt	Features
1.		
2.		
3.		
4.		

3. Draw the basic profile of metric thread.

Check Your Progress

A. Fill in the blanks

1. A fastener is a hardware _____ that mechanically joins or _____ two or more objects together.
2. Automotive fasteners are made up of a variety of _____.
3. A bolt is an externally threaded _____.
4. External threads are on the _____ or screws and internal threads are on the _____.
5. In India we use ISO _____ thread.

B. Multiple choice questions

1. Which automotive fastener(s) is (are) used for holding or connecting two or more objects in a machine?
   (a) Nuts and bolts
   (b) Wooden keel
   (c) Fibre joint
   (d) None of the above
2. What is the simple effective diameter of a screw thread?
   (a) Pitch diameter
   (b) Flank
   (c) Root
   (d) Threaded angle
3. What are the straight sides, which connect the crest and the root called?
   (a) Flank
   (b) Root
   (c) Minor diameter
   (d) Pitch diameter
4. Match the following

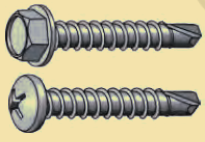
   (a) Eye bolt 

   (b) Flange bolt 

   (c) Frame bolt 

   (d) Hanger bolt 

5. Choose sheet metal screw on the basis of the head shape shown here

   (a) 

   (b) 

   (c) 

   (d) 

C. Answer the following questions

1. Describe the importance of bolts.
2. What are machine screws?
3. What is the importance of threads on bolt and machine screws?
4. Differentiate between bolt and screw.
5. What do you understand by metric thread? Make a profile of metric thread and state all the terminologies.

Fig. 2.10: Different types of nuts

Session 2: Automotive Nuts

An automotive nut is a type of fastener with a threaded hole. It is used opposite a mating bolt to hold together temporary or permanent structures. These nuts are generally square or hexagonal shaped. There are different types of automotive nuts, such as simple nuts, collar nuts, locking, etc. (Fig.2.10).

Thread Profile in Nut

A nut is screwed onto a bolt for joining two metal parts. Therefore, the thread profile of a bolt and nut must match and since we use metric threads in India, the nut being used in conjunction with the bolt must have metric threads as well. Mismatching of the profile and forcible screwing may damage the thread profile of a nut and bolt, and the nut will not fit on the bolt. The nut may have left hand or right hand internal threads.

Dimensions of Nut

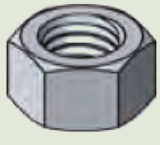
All the dimensions of ISO metric nut are related to the internal diameter of the nut.

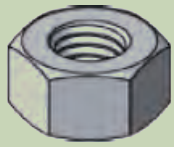
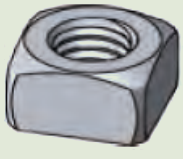
Material of Nuts

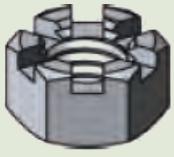
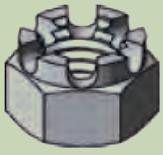
Nuts and bolts are made of the same material these include everything from aluminium to brass, copper alloy, plastic, steel, hardened steel, stainless steel, super alloys, titanium, etc.

Types of Nuts

The table given below lists the different types of nuts as per their type shape, and features.

Type	Shape	Features
Hex		It is a type of metal fastener that has six sides. They are used to fasten a bolt to another object.

Heavy hex		These nuts are larger and thicker than hex nuts. Heavy hex nuts are used for large diameter and high strength bolt applications.
Nylon insert lock		Some nuts use nylon as a locking feature. The nylon is inserted to seal the bolt thread against seepage of liquid material.
Jam		It is a thin nut used to lock a thicker nut. A thin nut is placed adjacent to the joint surface and tightened against the thick nut.
Nylon insert jam lock		It is low profile locknut which is fastened a bolt for mechanically joining material together. The nylon insert located at the top of the nut prevents loosening caused due to vibration.
Wing		It is a type of nut with two large metal 'wings', on each side. It can be easily tightened and loosened with hand.
Cap		These nuts cover the exposed portion of a threaded stud, rod and bolt ends. It is shaped like a dome.
Acorn		It is a nut fitted with a domed top. The external thread cannot be touched due to domed top.
Flange		It is a plate or ring used for connecting pipes, valves, pumps and other equipment, to form a piping system.
Tee		It is an internally threaded fasteners which is used for tightening wood, particle board, etc.
Square		It is a four-sided nut and has a greater surface.

Prevailing torque lock		It is a type of locknut, which resists loosening caused by shock, vibration and other dynamic forces.
K-lock or Kep		It is a nut with an attached free-spinning washer. It is used to make assembly more convenient.
Coupling		It is used to join two externally threaded rods together.
Slotted Hex Nuts		These nuts are used in many applications, but specifically in automotive bearing or wheel hub to spindle assemblies.
Castle nut		With nut slots (notches) cut into one end, it is a positive locking device. These nuts are used in low-torque applications, such as holding a wheel bearing in place.

Practical Exercise

1. List the types of nuts used in a vehicle and state their features.

S. No.	Type of bolt	Features
1.		
2.		
3.		
4.		

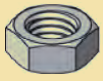
2. Draw the profile of ISO metric thread.

Check Your Progress

A. Fill in the blanks

1. A nut is a type of fastener with a _____ hole.
2. For joining two metal parts, the nut is screwed onto the _____.
3. The _____ of the bolt and nut must be same else the nut cannot be _____ on the bolt.
4. A nut can have left hand or right hand _____ threads.
5. A hexagonal nut is a type of metal fastener that has _____ sides.

B. Multiple choice questions

1. Which factor of the bolt and nut must be same for the nut to be screwed on the bolt?
   (a) Pitch
   (b) Minor diameter
   (c) Root
   (d) Flank
2. Which of the following is a hexagonal nut?
   (a) 
   (b) 
   (c) 
   (d) 
3. Which nut is used to join two externally threaded rods together?
   (a) Coupling
   (b) K-lock or Kep
   (c) Square
   (d) None of the above
4. Which nut is used specifically in automotive bearing or wheel hub to spindle assemblies?
   (a) Slotted Hex Nuts
   (b) Prevailing torque lock
   (c) K-lock or Kep
   (d) Square

NOTES

C. Answer the following questions

1. Describe the importance of nuts.
2. Why are nuts made of four or six faces?
3. What is the importance of threads in a nut?
4. What do you understand by ISO metric thread?
5. Name the different types of nuts.
6. Name the different types of machine screws.

Fig. 2.11: Different types of studs

Session 3: Automotive Studs

Automotive studs also known as double-ended automobile fastener has threaded on both the ends. One end of the stud is fixed to an object while the other end is typically mated with a nut. With the growing automotive parts industry, various automotive fasteners manufacturers and suppliers are coming up with new materials to manufacture a variety of auto studs.

Studs (Fig.2.11) are used for joining of parts. Due to low tensile strength of cast iron, cast iron thread gets damaged in excessive tightening process. It leads to permanent damage of the casting. They are also used in gas and water-tight joints in applications, where heavy pressures are created. In automobile, studs are used for holding down the cylinder head on a cylinder block of motor car engine. The joint between the cylinder and the head should be a temporary one.

On the basis of their usage, automotive studs can be categorised as engine studs, wheel studs and stainless steel studs.

Automobile studs are manufactured from brass, copper, plastic, nylon, aluminium, bronze and titanium.

Wheel Studs

Wheel studs are threaded fasteners that are used for holding the wheels of automobiles. These wheel studs are semi-permanently fixed directly to the vehicle hub. Lug nuts are used over the wheel stud for tightening

the wheel (Fig.2.12). When a wheel is removed for tyre change, etc., the stud remains in the hub. Many automobiles use bolts instead, where removable bolts are screwed into the wheel hub. Wheels that use bolts have one or more small locator pins to assist this. The wheel is lifted onto the pins, and then the bolts are inserted. Once the bolts are tightened and the wheel is fully installed, the pins have no further function whilst the vehicle is driven.

Fig. 2.12: Wheel stud

Types of Wheel Studs

Wheel studs are replaceable and come in two basic kinds:

(a) Screw-in and
(b) Press-in

Screw-in

Screw-in studs (Fig.2.13) are simply screwed into the existing threaded bolt hole in the hub. The end that screws into the hub is usually either threaded with a higher tolerance fit or installed with a chemical thread-locking fluid to keep it from backing out from the hub when the lag nut is removed.

Fig. 2.13: Screw-in type stud

Press-in

Press-in studs (Fig.2.14) are installed from the back side of the disc or drum hub and may require removal of the hub from the vehicle for installation or removal. They consist of a threaded portion and a larger diameter section, called the knurl, which is splined to prevent rotation. The diameter of the knurl is larger than the hole in the hub requiring a press fit to seat the stud. The stud is prevented from being pulled through the hub by a larger diameter stop on the end.

Fig. 2.14: Press-in type stud

Engine Studs

Main Studs

Main studs are used for heavy-duty application (Fig.2.15). It can replace main cap bolts. Main studs

provide the ability to obtain more accurate torque values. Studs do not twist during tightening. As bolts, the studs stretch in one axis alone. Use of studs results in less wear to the block's threads. Life of the threaded holes increases in the block over periods of servicing or rebuilding. The use of studs also eases main cap installation, and contributes to main cap alignment.

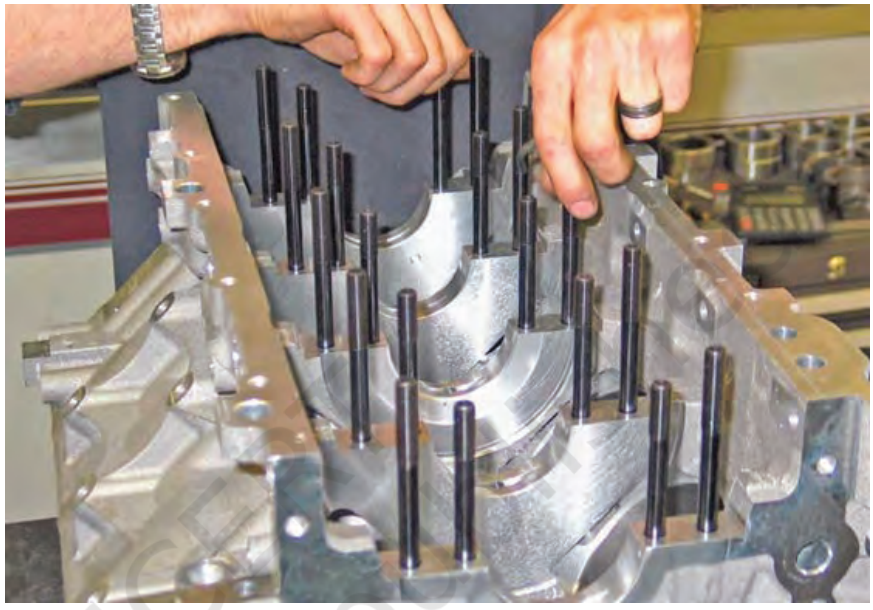


Fig. 2.15: Main studs in engine block

Cylinder Head Studs

The use of head studs, (Fig.2.16) help in cylinder head installation, simply from a standpoint of gasket and head alignment.

Use of studs provides much more accurate and consistent torque loading. When a bolt is installed, the act of tightening results in both twisting (torsional load) and stretching (vertical or axial load). This results in the bolt being exposed to two forces at the same time, as well as experiencing frictional loads at the thread engagement. When the nut is tightened on a stud, the stud stretches on its vertical axis only. The exposed end (top) of the stud features 'fine' threads, which allow more precise and therefore accurate, torque readings when the nut is torqued (or torque or angle tightened) to specifications.

Fig. 2.16: Cylinder head studs

Practical Exercise

1. List the types of studs used in a vehicle.

S.No.	Type of studs
1.	
2.	
3.	
4.	

2. Draw different types of studs used in automobile.

Check Your Progress

A. Fill in the blanks

1. Studs are mechanical _____ which are _____ on one or both ends.
2. Automotive studs are _____ at both the ends.
3. Wheel studs are the threaded fasteners that hold on the _____ of automobiles.
4. Press-in studs are installed from the back side of the _____ or _____.
5. For a performance or _____ application, the use of _____ is preferred whenever possible instead of main cap bolts.

NOTES

B. Multiple choice questions

1. Fasteners which are threaded on one or both ends are known as _____.
   (a) studs
   (b) welding
   (c) casting
   (d) rivets
2. On the basis of their usage, automotive studs can be categorised as _____.
   (a) engine studs
   (b) wheel studs
   (c) stainless steel studs
   (d) All of the above
3. Wheel studs are used in automobiles for _____ _____.
   (a) holding the wheels
   (b) holding the chassis
   (c) holding the frame
   (d) All of the above
4. Main studs can replace _____.
   (a) main cap bolts
   (b) screw-in
   (c) press-in
   (d) All of the above
5. Which wheel stud can be replaced if broken?
   (a) Screw-in and press-in
   (b) Engine studs
   (c) Stainless steel
   (d) All of the above

C. Answer the following questions

1. What are the advantages of studs over bolts?
2. In what conditions should studs be used in place of bolts?
3. Differentiate between bolt and stud.
4. Name the different types of studs.

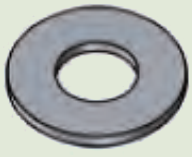
SESSION 4: AUTOMOTIVE WASHERS AND RIVETS

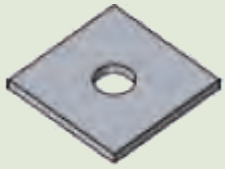
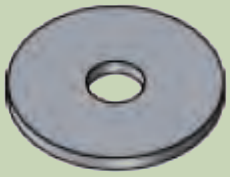
A washer is a thin plate with a hole. It is normally used to distribute the load of a screw or nut. It acts as a spring, locking device, spacer, wear pad and also reduces vibration. A washer's, outer diameter (OD) is twice the width of its inner diameter (ID).

Automotive washers are small flat dishes with a hole in the center. The main function of an automotive washer is to hold or bear the load of a threaded fastener or bolt. Washers are put below a nut, axle bearing or joint with the main purpose of preventing leakage and distributing pressure. The automotive washers include bolt lock washers, cylinder head washers, lug nut washers, radiator washers and hardened washers. These essential auto fasteners are generally made of metal, leather, plastic or rubber.

Fig. 2.17: Different types of washers

The table given below lists the different types of washers as per their type, shape and features.

Type	Shape	Features
Flat		They are kept under the head of a bolt or nut for providing a smooth bearing surface as well as to distribute the fastener load over a wider surface area.
Fender		It is a flat washer with a large outer diameter in proportion to its central hole. It is commonly used to spread the load on thin sheet metal.
Finishing		It is designed to accommodate the heads of a countersunk screw in order to provide a finished appearance.
Split lock		It is a split type of spring washer whose purpose is to prevent self loosening of the nut or the bolt.
External tooth lock		It is also known as a serrated washer or star washer, has serrations that extend radially inward and/or outward to bite into the bearing surface.

Internal tooth lock		It has serrations along the inner edge of the washer, which makes it aesthetically pleasing
Square plate		It is made from low carbon steel and has a larger surface area than round washers. This type of washer is used in timber construction.
Dock		It has an outside diameter measuring up to a 100mm. Dock washer is used for heavy duty load bearing applications.
Ogee		It is typically used in dock and wood construction. These oversized washers have a large bearing surface designed to prevent bolt heads and nuts from pulling into the wood.
Sealing		It is made from a silicone rubber section, molded and bonded to a stainless steel formed washer. It is vibration-resistant. They are designed for use with regular screws, bolts or studs for sealing panels and enclosures having large or irregular clearance.

Rivets

Rivets are semi-permanent mechanical fasteners. Before being installed, a rivet consists of a smooth cylindrical shaft with a head on one end. Rivets are used as automobile fasteners in a wide number of applications like vehicle bodies, aircraft, bridges, cranes, building

Fig. 2.18: Different types of rivets and rivet joint

frames, etc. Rivet is held in place and the metal parts are joined. The joint can be opened by removing the deformed end of the rivet by chisel or grinding. Rivets and riveted joint are shown in Fig.2.18.

Types of Rivets

Rivets are usually categorised on the basis of their heads as shown in Fig.2.19. The material of the rivets must be tough and ductile. They are usually made of steel (low carbon steel or nickel steel), brass, aluminium or copper, etc. However, when strength and fluid tight joint is the main consideration.

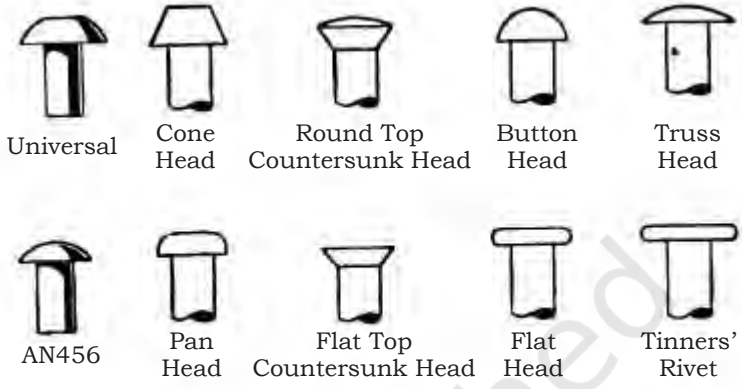


Fig. 2.19: Common types of rivets

Making rivet heads with hand rivet set

The rivet head on the rivet is made using a hand rivet set as shown in Fig.2.20. The sheet metal to be joined by riveting is drilled according to the size of the rivet shank. The holes are aligned and the rivet is inserted into the holes. The deep hole of the rivet set is used to draw the sheets and rivet together and also the rivet directly through thin sheeting. The rivet set selected should have a hole, slightly larger than the diameter of the rivet. The rivet shank is hammered keeping the shallow cone hole of the rivet set on the protruding end of the rivet. A good job of riveting can be done with not more than six normal blows of the hammer, and after a little practice this number can be cut by half.

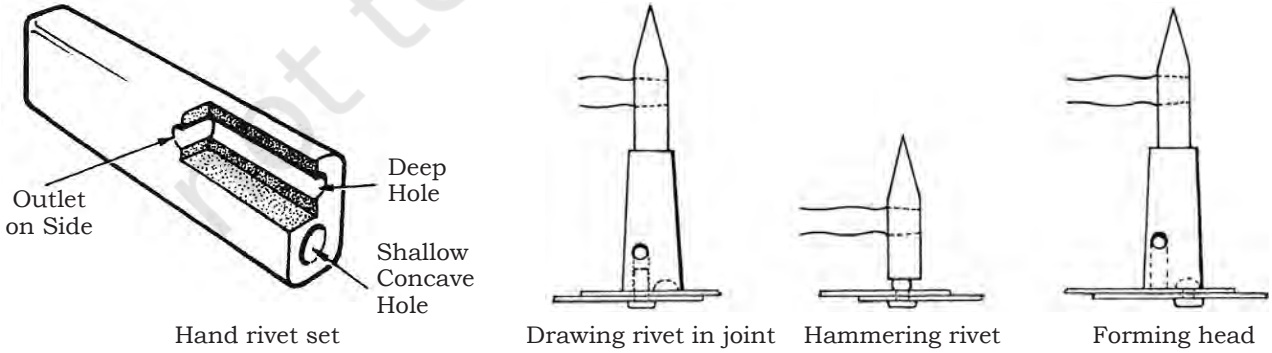


Fig. 2.20: Forming rivet heads

Fig. 2.21: Circlip and circlip plier

Other Important Fasteners

There is a vast array of different types of fasteners used in the automobile industry. Some other important fasteners have been given below.

Circlip

A circlip, is a type of fastener consisting of a semi-flexible metal ring with open ends. It can be snapped into place, into a machined groove on a dowel pin or other part to permit rotation but to prevent lateral movement. Circlips are often used to secure pinned connections. These are used to retain piston wrist pins or gudgeon pins, the clips are known as wrist pin clips or wrist pin retainers or gudgeon pin clips. The most commonly used circlip for this application is a simple spring steel circlip (snap ring), or plain wire ring. A circlip and circlip plier are shown in Fig.2.21.

Split Pin

A split pin is a metal fastener with two tines that are bent during installation. Split pins are generally made of soft metal, making them easy to install and remove. Common materials used in its manufacture may be mild steel, brass, bronze, stainless steel and aluminium. A new split pin (see Fig. 2.22 A) has its flat inner surfaces touching for most of its length so that it appears to be a split cylinder (Fig.2.22 D). Once inserted, the two ends of the pin are bent apart, locking it in place (Fig.2.22 B). When they are removed they are supposed to be discarded and replaced, because of fatigue from bending.

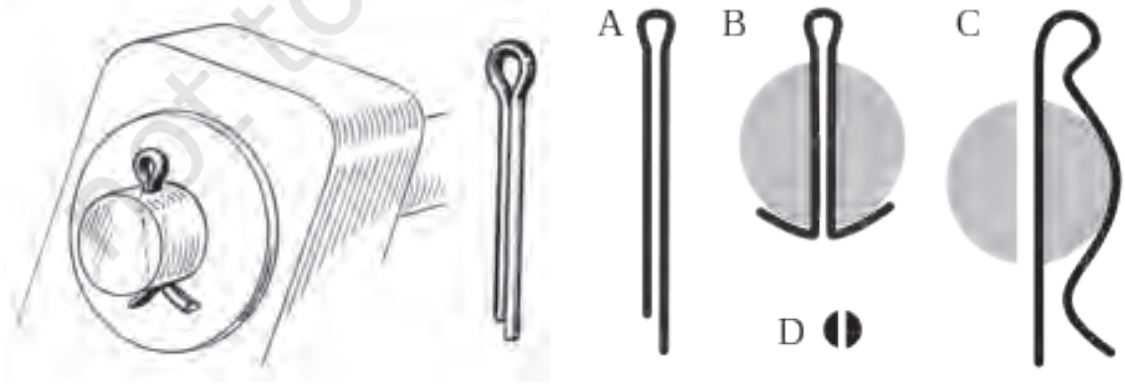


Fig. 2.22: Split pin in shaft. A-new, B-installed, C-spring type, D-cross-section

Spring Pin

A spring pin (Fig.2.23) is a mechanical fastener that joins two or more parts of a machine relative to each other. Spring pins have a body diameter which is larger than the hole diameter, and a chamfer on either one or both ends to facilitate starting the pin into the hole. The spring action of the pin allows it to compress as it assumes the diameter of the hole. The radial force exerted by the pin against the hole wall retains it in the hole, therefore a spring pin is considered a self retaining fastener.

Fig. 2.23: Slotted spring pin (1) and washer (2) used to secure a shaft (3)

Practical Exercise

1. List the different types of washers used in a vehicle and state their features.

Sr. No.	Type	Features
1.		
2.		
3.		
4.		

2. Draw different types of rivets used in an automobile.

Check Your Progress

A. Fill in the blanks

1. A washer is a thin _____ with a hole that is normally used to _____ the load of a threaded _____.
2. Automotive washers are small flat _____ with a _____ in the center.
3. Rivets are _____ mechanical fasteners.

4. Rivets are categorised on the basis of their _____.
5. Circlips are often used to secure _____.
6. Split pins are typically made of _____ metal, making them easy to _____ and remove.
7. Spring pins have a body diameter which is larger than the _____ diameter, and a _____ on either one or both ends to facilitate _____ the pin into the hole.

B. Multiple choice questions

1. A washer is used to distribute the load of a _____.
   (a) screw or nut
   (b) chassis
   (c) wheel
   (d) None of the above
2. A washer's outer diameter (OD) is twice the width of their _____.
   (a) inner diameter
   (b) pitch
   (c) flank
   (d) None of the above
3. Which of these is a flat washer?
   (a) 
   (b) 
   (c) 
   (d) 
4. Which of the following type of washers is used in timber construction?
   (a) Square
   (b) Dock
   (c) Ogee
   (d) Split lock
5. Which of the following is a semi-permanent mechanical fastener?
   (a) Rivet
   (b) Nut and bolt
   (c) Studs
   (d) None of the above

C. Answer the following questions

1. Describe the importance of washers.
2. What is the importance of rivets?
3. What are the advantages of using washers as fasteners?
4. In what conditions should rivets be used as fasteners?
5. What are the advantages of using split pin as fastener?
6. What are the advantages of using spring pin as fastener?
7. Name different types of washers.
8. Name different types of rivets.
9. List the uses of circlip.

Session 5: Removal and Replacement of Damaged Fasteners

Removal of Broken or Spoiled Headed Screw

In automobiles, jerk, vibration and corrosion can cause the screw to break. This leads to dislocation of the assembly. Therefore, it should be removed and replaced. Similarly improper use of screw drivers with its snap head can spoil the screw head, which makes it difficult to tighten, loosen or remove the screw from the assembly. Fig.2.24 shows broken and spoiled screws.

Fig. 2.24: Broken and spoiled screws

Method of Removal of Damaged Screw

Case 1: Removal of spoiled headed screw

If the screwdriver keeps slipping, due to widening of the groove or screw way:

- Use a hacksaw blade and dress the groove.
- Then use a screwdriver with a thick snap, place it on the screw head and turn it anti-clockwise.
- This removes the screw, if it is not responded.
- Take a prick punch and hammer. Give a light blow in anti clockwise direction. This loosens the screw.

Fig. 2.25: Unheaded screw

- If it does not work use a drill machine with a drill bit smaller than the size of the screw.
- Now drill it at the centre of screw, the screw will get removed.

Case 2: Removal of unheaded screw

If the screw is broken at the top of the assembly

- remove the other screw and separate the assembly,
- hold the jaws of the clipper on broken screw,
- lock the clipper and turn it anti-clockwise and
- the screw will come out.

Case 3: Removal of unheaded screw broken in the assembly

- Use a drill machine with drill bit smaller than the size of screw.
- Now drill it at the centre of the screw. The screw will get removed.
- Dress the threads before fixing a new screw.

Fig. 2.26: Broken bolt

Broken Nut or Bolts

Jerky movement and vibration cause loosening of nuts and bolts in automobiles and also spoil their internal and external threads. Also, this slackens the assembly unit and changes its alignment. Improper use of spanners or socket may lead to spoiling of edges of their edges. It is necessary that broken nuts and bolts are removed or replaced else it becomes difficult to tighten, loosen or remove the nut or bolt from the assembly. Fig.2.26 shows a broken bolt.

Method of Removal of Spoiled Headed Nut or Bolts

Case 1: Removal of nut or Bolts

- Use spanner of smaller size, fix it on the nut or bolt and turn anti-clockwise. It will come out.
- If it does not come out take a prick punch and hammer at the face of nut or bolt. Give a light blow in anti-clockwise direction. This loosens the nut or bolt.
- If this also does not work, use a drill machine with drill bit smaller than the size of nut or bolt.

Fig. 2.27: Broken thread

- Now drill it at the centre of nut or bolt and remove the edges of the nut, in the case of a bolt, remove the bolt head by using a clipper and remove the remaining part of the bolt from the assembly.

Case 2: Dress the internal threads of the bolts by using a tap of appropriate size

- In the case of nut, use a die to rethread the stud threaded portion and use a new nut.

Broken or Spoiled Threaded Studs

A stud is stronger than a bolt, if installed correctly. The stud is screwed into the threaded hole without applying pressure to or galling the threads. After stud installation, the parts are slipped over the stud and the washer is installed.

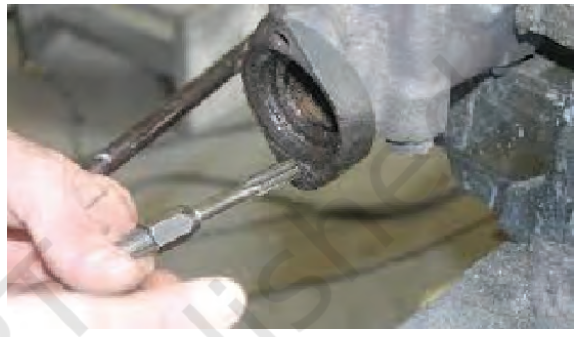


Fig. 2.28: Removal of thread

The stud is stronger as the thread contact at the stud and the threaded hole is stationary, when pressure is applied (while tightening the fastener). But when a bolt is used to mount a part, the bolt is rotated in the threaded hole during tightening, which can tear out weak threads.

There will be times when clearance problems will make it impossible to use a stud instead of a bolt. Sometimes there is no room to slip a large part over a stud, but rather the part has to be slipped into place from the side. But if a stud is used instead of a bolt, the studs will result in better fastener strength than a bolt.

Method of Removal of Broken or Spoiled Threaded Studs

Case 1: Removal of spoiled threaded studs

- To remove a spoiled threaded stud, apply gentle pressure on the assembly with a screwdriver. This will lift the spoiled portion of the stud threads upward.
- Turn the nut anti-clockwise, turn the stud assembly and gently press the screw driver inside for the stud to come out.

- If the nut threads, i.e., internal threads of the nut or external threads of the studs are spoiled, then weld the spot to nut and stud. Now turn the assembly anti-clockwise, a the stud will come out.

Case 2: Removal of broken studs above the casing

- If the stud above the assembly unit is broken, separate the assembly by removing other nuts.
- Fix the stud extractor on the broken stud and lock it.
- Now turn the stud extractor slowly, the stud will come out.

Case 3: Removal of broken studs inside the casing

- Take a prick punch and hammer on the face of broken stud. Give a light blow in anti-clockwise direction. This will loosen the remaining portion of the stud.
- If it does not work, use a drill machine with drill bit smaller than the size of the stud.
- Now drill it at the centre of the stud. Remove the burr from the casing.
- Use an appropriate tap and redress the internal thread.
- Fix the new stud using a stud extractor.

Fig. 2.29: Anti-rust solution

Use of Anti-rust Solution

Anti-rust solution is used for dissolving the dust and rust on the fastener. This solution makes the process of removing or changing fasteners easier. Nowadays Indian as well as imported anti-rust solution or sprays are available in the market. Fig.2.29 shows anti-rust.

Check Your Progress

A. Fill in the blanks

1. In automobile screws get broken due to _____, vibration and _____.
2. To remove a spoiled headed screw use hacksaw _____ and dress the _____.
3. In automobile, due to _____ movement and vibration, nuts and bolt get _____.

4. A stud is stronger than a _____.
5. Anti-rust solution is used for dissolving the _____ in the fastener.

B. Multiple choice questions

1. For removing a spoiled headed screw _____.
   (a) use hacksaw blade and dress the groove.
   (b) remove the screw, if it does not respond
   (c) Both of the above
   (d) None of the above
2. Remove unheaded screw if _____.
   (a) the screw is broken at the top of the assembly
   (b) the other screw and separate the assembly
   (c) comes out
   (d) All of the above
3. How to remove an unheaded screw broken in the assembly?
   (a) Dress the threads before fixing new screw
   (b) Drill in to the centre of screw, it will be removed
   (c) Use drill machine with a smaller drill bit than that of the screw
   (d) All of the above

C. Answer the following questions

1. Give the process of removing screw with spoiled head.
2. How is a screw without head removed?
3. List the steps to remove unheaded screw broken in the assembly.
4. Give the steps to remove broken or spoiled threaded studs.

NOTES

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-2 SESSION-1

A. Fill in the blanks

1. A fastener is a hardware _____ that mechanically joins or _____ two or more objects together.
2. Automotive fasteners are made up of a variety of _____.
3. A bolt is an externally threaded _____.
4. External threads are on the _____ or screws and internal threads are on the _____.
5. In India we use ISO _____ thread.

B. Multiple choice questions

1. Which automotive fastener(s) is (are) used for holding or connecting two or more objects in a machine?
   (a) Nuts and bolts
   (b) Wooden keel
   (c) Fibre joint
   (d) None of the above
2. What is the simple effective diameter of a screw thread?
   (a) Pitch diameter
   (b) Flank
   (c) Root
   (d) Threaded angle
3. What are the straight sides, which connect the crest and the root called?
   (a) Flank
   (b) Root
   (c) Minor diameter
   (d) Pitch diameter
4. Match the following

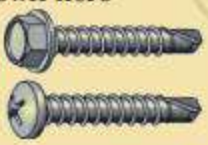
   (a) Eye bolt 

   (b) Flange bolt 

   (c) Frame bolt 

   (d) Hanger bolt 

5. Choose sheet metal screw on the basis of the head shape shown here

(a) 

(b) 

(c) 

(d) 

C. Answer the following questions

1. Describe the importance of bolts.
2. What are machine screws?
3. What is the importance of threads on bolt and machine screws?
4. Differentiate between bolt and screw.
5. What do you understand by metric thread? Make a profile of metric thread and state all the terminologies.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-2 SESSION-2

A. Fill in the blanks

1. A nut is a type of fastener with a _____ hole.
2. For joining two metal parts, the nut is screwed onto the _____.
3. The _____ of the bolt and nut must be same else the nut cannot be _____ on the bolt.
4. A nut can have left hand or right hand _____ threads.
5. A hexagonal nut is a type of metal fastener that has _____ sides.

B. Multiple choice questions

1. Which factor of the bolt and nut must be same for the nut to be screwed on the bolt?
   (a) Pitch
   (b) Minor diameter
   (c) Root
   (d) Flank

2. Which of the following is a hexagonal nut?

(a) 

(b) 

(c) 

(d) 

3. Which nut is used to join two externally threaded rods together?
   (a) Coupling
   (b) K-lock or Kep
   (c) Square
   (d) None of the above
4. Which nut is used specifically in automotive bearing or wheel hub to spindle assemblies?
   (a) Slotted Hex Nuts
   (b) Prevailing torque lock
   (c) K-lock or Kep
   (d) Square

C. Answer the following questions

1. Describe the importance of nuts.
2. Why are nuts made of four or six faces?
3. What is the importance of threads in a nut?
4. What do you understand by ISO metric thread?
5. Name the different types of nuts.
6. Name the different types of machine screws.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-2 SESSION-3

A. Fill in the blanks

1. Studs are mechanical _____ which are _____ on one or both ends.
2. Automotive studs are _____ at both the ends.
3. Wheel studs are the threaded fasteners that hold on the _____ of automobiles.
4. Press-in studs are installed from the back side of the _____ or _____.
5. For a performance or _____ application, the use of _____ is preferred whenever possible instead of main cap bolts.

B. Multiple choice questions

1. Fasteners which are threaded on one or both ends are known as _____.
   (a) studs
   (b) welding
   (c) casting
   (d) rivets
2. On the basis of their usage, automotive studs can be categorised as _____.
   (a) engine studs
   (b) wheel studs
   (c) stainless steel studs
   (d) All of the above
3. Wheel studs are used in automobiles for _____ _____.
   (a) holding the wheels
   (b) holding the chassis
   (c) holding the frame
   (d) All of the above
4. Main studs can replace _____.
   (a) main cap bolts
   (b) screw-in
   (c) press-in
   (d) All of the above

5. Which wheel stud can be replaced if broken?
   (a) Screw-in and press-in
   (b) Engine studs
   (c) Stainless steel
   (d) All of the above

C. Answer the following questions

1. What are the advantages of studs over bolts?
2. In what conditions should studs be used in place of bolts?
3. Differentiate between bolt and stud.
4. Name the different types of studs.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-2 SESSION-4

A. Fill in the blanks

1. A washer is a thin _____ with a hole that is normally used to _____ the load of a threaded _____.
2. Automotive washers are small flat _____ with a _____ in the center.
3. Rivets are _____ mechanical fasteners.
4. Rivets are categorised on the basis of their _____.
5. Circlips are often used to secure _____.
6. Split pins are typically made of _____ metal, making them easy to _____ and remove.
7. Spring pins have a body diameter which is larger than the _____ diameter, and a _____ on either one or both ends to facilitate _____ the pin into the hole.

B. Multiple choice questions

1. A washer is used to distribute the load of a _____.
   (a) screw or nut
   (b) chassis
   (c) wheel
   (d) None of the above
2. A washer's outer diameter (OD) is twice the width of their _____.
   (a) inner diameter
   (b) pitch
   (c) flank
   (d) None of the above

3. Which of these is a flat washer?

(a) 

(b) 

(c) 

(d) 

4. Which of the following type of washers is used in timber construction?
   (a) Square
   (b) Dock
   (c) Ogee
   (d) Split lock
5. Which of the following is a semi-permanent mechanical fastener?
   (a) Rivet
   (b) Nut and bolt
   (c) Studs
   (d) None of the above

C. Answer the following questions

1. Describe the importance of washers.
2. What is the importance of rivets?
3. What are the advantages of using washers as fasteners?
4. In what conditions should rivets be used as fasteners?
5. What are the advantages of using split pin as fastener?
6. What are the advantages of using spring pin as fastener?
7. Name different types of washers.
8. Name different types of rivets.
9. List the uses of circlip.

A. Fill in the blanks

1. In automobile screws get broken due to _____, vibration and _____.
2. To remove a spoiled headed screw use hacksaw _____ and dress the _____.
3. In automobile, due to _____ movement and vibration, nuts and bolt get _____.
4. A stud is stronger than a _____.
5. Anti-rust solution is used for dissolving the _____ in the fastener.

B. Multiple choice questions

1. For removing a spoiled headed screw _____.
   (a) use hacksaw blade and dress the groove.
   (b) remove the screw, if it does not respond
   (c) Both of the above
   (d) None of the above
2. Remove unheaded screw if _____.
   (a) the screw is broken at the top of the assembly
   (b) the other screw and separate the assembly
   (c) comes out
   (d) All of the above
3. How to remove an unheaded screw broken in the assembly?
   (a) Dress the threads before fixing new screw
   (b) Drill in to the centre of screw, it will be removed
   (c) Use drill machine with a smaller drill bit than that of the screw
   (d) All of the above

C. Answer the following questions

1. Give the process of removing screw with spoiled head.
2. How is a screw without head removed?
3. List the steps to remove unheaded screw broken in the assembly.
4. Give the steps to remove broken or spoiled threaded studs.

Unit 3

Material

In Level I, you learnt about the basic assessment of an automobile and its components. This unit will discuss the material used to make these components and its manufacturing methods.

Session 1: Engineering Material

We hear a lot about the parts that make up a vehicle, such as engines, transmissions, seats, HVAC (ventilation, air conditioning and heating) systems, and so on. But have you ever thought what material is used to make them?

The automobile industry uses various material, such as, iron, aluminium, plastic, glass, steel, rubber, petroleum products copper, etc., to produce different components, such as dashboard, transmission gears or the engine block.

Classification of Engineering Material

This material is available with spacious range of properties and characteristics. There are many properties, which are inherent in the material and some of them can be changed during processing and manufacturing.

Engineering material can be classified into two category—metals and non-metals (Fig.3.1).

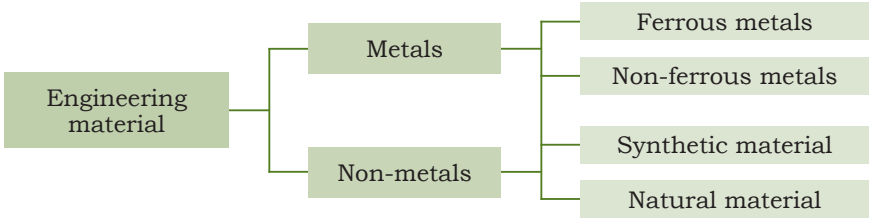


Fig. 3.1: Engineering materials

Metals

Metals are the most commonly used engineering material. They can be further classified into non-ferrous and ferrous metals.

Ferrous metals

When metal or alloy contains iron, it is known as ferrous metal. Ferrous metals are durable and strong hence used in applications that require tensility at a relatively low cost. These metals are used in making tools, vehicle engines, pipelines, automobiles, bridges, etc. Fig.3.2 shows the family of ferrous material.

Carbon steel

Many sophisticated alloys have been developed in the recent years but steel seems to remain the most commonly used engineering material. Steel is an alloy of carbon and iron and contains less than 2% carbon. Steels containing about 0.03% to 1.2% carbon are called plain carbon steels. Besides carbon, it also contains silicon, manganese, sulphur and phosphorous.

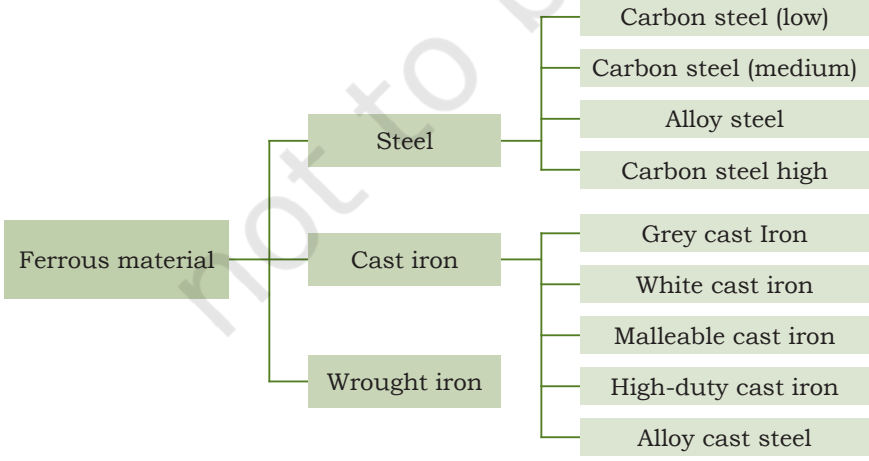


Fig. 3.2: Family of ferrous material

Dead mild steel

Steels containing up to 0.15% carbon are called dead mild steel. It is a soft and highly ductile material and can be easily formed. Car bodies, deep drawn components, tinplate, nails, rivets, thin wires, etc., are made from dead mild steel.

Mild steel

It contains approximately 0.15–0.3 % carbon, making it malleable and ductile. Mild steel has a relatively low tensile strength but it is cheap and easy to form. It is used for making structural members, shaft, levers, screws, nails, wires screws, etc. Mild steel is coated with tin to make cans for food and beverages.

Medium carbon steel

It is also called constructional steel. Medium carbon steel contains carbon from 0.4–0.6 %. It is strong, heat treatable, and thus has wide range of properties in the quenched and tempered state. It is used for applications where strength and toughness are required. Fasteners, shafts, axles, crankshafts, connecting rods, gears, wire ropes, rails, etc., are made using medium carbon steels.

High carbon steel

Any steel with, 0.7–1.2 % carbon called high carbon steel. It has the highest hardness and toughness of the carbon steels and the lowest ductility. They are wear resistant and therefore always hardened and tempered. It is used to make machine tools, cold chisels, axes, dies, taps, drills and saws, hammers razors, etc.

The main limitations of the plain carbon steels in engineering applications are:

1. High strength steel can be obtained by having high carbon contents, which makes it brittle. It is not possible to achieve high strength with high ductility and toughness.
2. Hardening requires rapid cooling rate, which can lead to distortions and cracking during quenching operations.
3. Large sections cannot be hardened uniformly due to variation in cooling rate.

4. Plain carbon steels have poor resistance to corrosion and oxidation at high temperatures.

Small and medium carbon steel is used for constructional works and structural and high carbon steel is used for manufacturing tools and components, which need to be wear-resistant and hard.

Fig. 3.3: Use of steel in car

In cars (Fig.3.3), steel is used to build a cage beneath the chassis that forms the skeleton of the vehicle and protects the occupants in the event of a crash. In most cars, door beams, roofs and body panels are also made by using steel.

Steel manufacturing is evolved, and so carmakers these days have been creating different types of steel for dissimilar areas of the vehicle that are crumple to rigid or that can absorb changed impacts.

Table below describes the uses of plain carbon steel in different component in material.

Alloy steel

Alloy steel is steel that is alloyed with several elements, such as manganese, silicon, metal, titanium, copper, chromium and aluminium to enhance its properties. For example, stainless steel is an alloy steel in which nickel and chromium are added in various proportion to make plain carbon steel.

Various alloys, such as increased hardness, corrosion resistance, strength, improved formability (ductility) and weldability. Alloy steels can be classified into three categories: low alloy steels, which contain up to 5% alloying elements; and high alloy steel, which contains more than 10% alloying elements.

Alloy steels is used in exhaust silencers and catalytic converters, pillars of car doors, bus bodies, fuel union components, shafts, motorcycle frames, bicycle rims, motorcycle wheel rims, etc.

High-strength low alloy steel (HSLA)

High-strength low alloy steel is a type of alloy steel that provides better mechanical properties than carbon

Fig. 3.4: Cylinder head made of cast iron

steel. With 0.05%–0.25% carbon. It can be easily formed and welded. It is used in automobiles, bridges, roller coasters and other structures that are designed to handle large amounts of stress or need a good strength-to-weight ratio. HSLA steels are mostly 20% to 30% lighter in weight than carbon steel of similar strength.

Cast irons

An allow of iron containing 2% and 4 % carbon along with silicon, manganese, sulphur and phosphorus chemical supplement, is called cast iron.

With its relatively low melting point, good castability, rigidity, fluidity, cast iron has become an engineering material with a wide range of applications. Many products such as pipes, machine castings, ornamental castings, casings and blocks of many automobile and tractor assemblies, heavy parts not subjected to tension or shock loads, agricultural machine parts, etc., are made of cast iron.

They are four basic types of cast irons, which are as follows:

Grey cast iron

The grey cast iron when fractured, has a grey appearance and a graphite smudge, which can usually be obtained on the finger, when rubbed on the surface. The grey cast iron has a composition of 2.5%–4% carbon, 1%–3% silicon, 0.4%–1.0% manganese, 0.15%-1% phosphorus and 0.1% sulphur.

Grey cast iron has excellent compressive strength, machinability, and vibration damping characteristics. It is wear and corrosion resistant, which makes it a good choice for casting applications. Grey cast iron is used to make automobile engines, cylinders blocks, cylinder head, gear box case, flywheels, crank case and pistons, machine castings, machine tool beds, etc.

White cast iron

The fast cooling of iron with 2% – 4.3 % carbon produces white cast iron. Due to the presence of a large amount of iron carbide, it is brittle and hard; and finds applications where abrasion resistance is required.

Malleable cast iron

It is essentially white cast iron, which has been modified by heat treatment. It is formed when white cast iron is heated to around 920 °C and then left to cool very slowly. It has good tensile strength, excellent impact strength, corrosion resistance and match inability. It can be used for making axle bearings, track wheels, automotive crankshafts, etc.

Spheroidal graphite cast iron

Also called nodular cast iron or ductile cast iron, spheroidal graphite cast iron has graphite present in it as tiny spheres or nodules. It is produced by adding magnesium or cerium to iron before casting. The nodular cast iron is more ductile and strong than grey cast iron. The combination of high ductility, strength, and cast ability makes ductile cast iron a rather attractive engineering material. It finds application in creation of gears, camshafts, crankshafts, etc.

Alloy cast iron

It contains alloying elements, such as nickel, chromium, molybdenum, vanadium copper, etc., to increase the strength or facilitate heat treatment.

The composition and uses of some typical cast irons are given in Table 3.1.

Table 3.1: Uses of cast irons

Composition (in %)					
C	**Si**	**Mn**	**S**	**P**	**Uses**
3.50	1.15	0.8	0.07	0.10	Heat-resisting castings and ingot moulds
3.30	1.90	0.65	0.08	0.15	Automobile brake drums
3.25	2.25	0.65	0.10	0.15	Automobile cylinders and pistons
3.25	2.25	0.50	0.10	0.35	Light machine castings
3.25	1.75	0.50	0.10	0.35	Medium machine castings

3.25	1.25	0.50	0.10	0.35	Heavy machine castings
3.60	1.75	0.50	0.10	0.80	Light and medium water pipes
3.40	1.40	0.50	0.10	0.80	Heavy water pipes
3.50	2.75	0.50	0.10	0.90	Ornamental castings requiring low strength-now obsolete

Wrought iron

Wrought iron is an iron alloy containing about 0.03% carbon and up to 1.8% impurities, which are mainly slag. It is extremely tough, malleable and ductile and can be easily formed and joined by forge welding. Due to its relatively low strength, it is mainly used for decorative and architectural iron works, such as for making railings, outdoor stairs, fences and gates, nuts and bolts, handrails, etc.

Non-ferrous Metals and Alloys

Non-ferrous metals are pure metals. These metals and alloys are used due to their desirable properties, such as corrosion resistance, thermal and electrical conductivity. However, these are not used as structural materials due to low mechanical strength.

Copper alloys, such as bronze, are corrosion resistant, strong, and machinable and have high melting points. These are used in making valve components of steam and hydraulic machines and in marine applications.

Brass is another important alloy of copper, which can be easily formed to shape. Brass is used in the

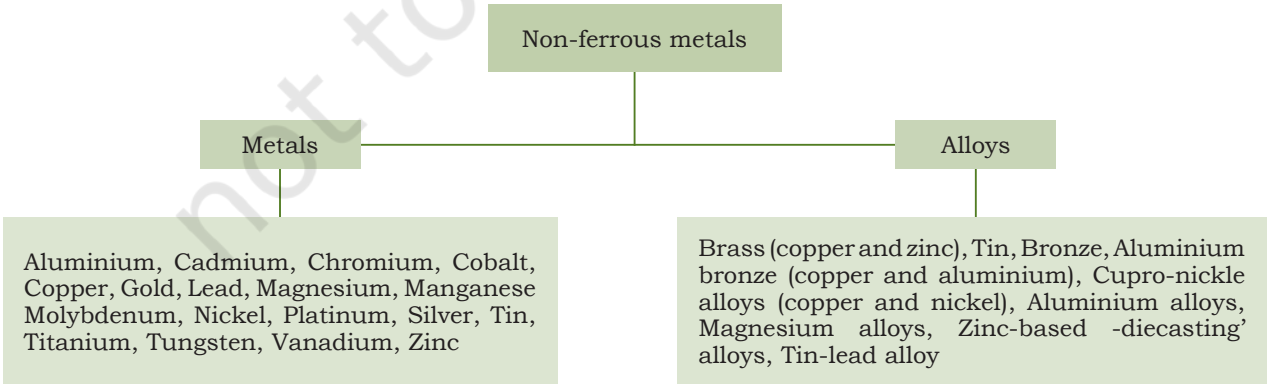


Fig. 3.5: Family of non-ferrous material

manufacturing of electrical components, domestic water fittings and plant protection equipment.

Aluminium alloys have become important engineering materials due to their lightweight, corrosion resistance and fairly good strength properties. They are widely used in aircraft, electrical and automobile industries, and to limited extent in farm machines.

Fig.3.5 shows the family of non-ferrous materials.

Some important non-ferrous metals and alloys used in automobiles have been given below.

Aluminium

Aluminium has been used to manufacture automobiles for many years. High specific energy density and good specific strength are its most important properties. It is recyclable and corrosion-resistant too. However, it cannot replace steel parts of auto components. Nowadays, aluminium is being used to make vehicle covers, power trains, and air conditioning body structure. Aluminium castings have been constructive to a variety of automobile parts for a long period. In automotive power train, aluminium castings have been used for roughly percentage of pistons, cylinder heads, 85% about 75% of intake manifolds and transmission (other parts-rear axle, and drive shafts, etc.) For chassis applications, aluminium castings are used for about 40% of wheels, for bracket, brake apparatus, suspension (control arms, supports), steering components (air bag supports, steering shafts, knuckles, housings, wheels) and instrument panels. Developments in this sector have demonstrated that up to 50% weight saving can be achieved by the replacing of steel by aluminium. 20%–30% of total vehicle weight decreases may also be achieved to other reduction opportunity.

Magnesium

Magnesium is the lightest metallic construction material that is used in automotive engineering. Magnesium is 33% lighter than aluminium and 75% lighter than steel or cast-iron apparatus. The corrosion resistance of magnesium alloys is also superior than that of traditional aluminium die-cast alloys. Therefore, development in

magnesium alloys, and coating technologies have made it a strong, lightweight and cast-effective solution of communication housings or parts of bonnets and doors for lightweight cars.

Copper and brass

Copper, brass and additional copper-based alloys meet the requirements of electrical conductivity, durability and strength in automobile. The average car contains approximately 23 kilograms (including 18 kilograms of electrical components). Copper and brass together make about 1 to 2% of a vehicles weight. It is expected that "hybrid vehicles" will use almost double the amount of copper (approx. 45 kg) approximation to that of traditional vehicles. Over the next few years, new copper-brass car and truck radiators that could last ten years will debut in the automotive industry. They will replace aluminium components of today's vehicle. Radiators are 35%–40% lesser in weight and correspondingly lower in material costs. Brass's valuable properties and relative ease of production has made it one of the most widely used alloys. Nuts, bolts, threaded parts, terminals, jets, taps, injectors, valve bodies, pipe and water fittings, parts of transmission, bushing, etc., are made from brass.

Synthetic Material

Fig.3.6 shows the categorisation of synthetic material. Plastics and composites have found their use in today's automobile. Some of them have been explained below.

Plastics

Plastics, a key material used in the automotive industry, is lightweight, corrosion resistant, flexible, durable and gives high performance at low costs. The properties of plastic can be improved through chemical.

Let us look at the advantages of using plastic in the automobile industry:

- It is durable, and impact-resistant and corrosion-resistant.
- It is flexible, allowing freedom in designing and mixing of components.
- It is inexpensive.

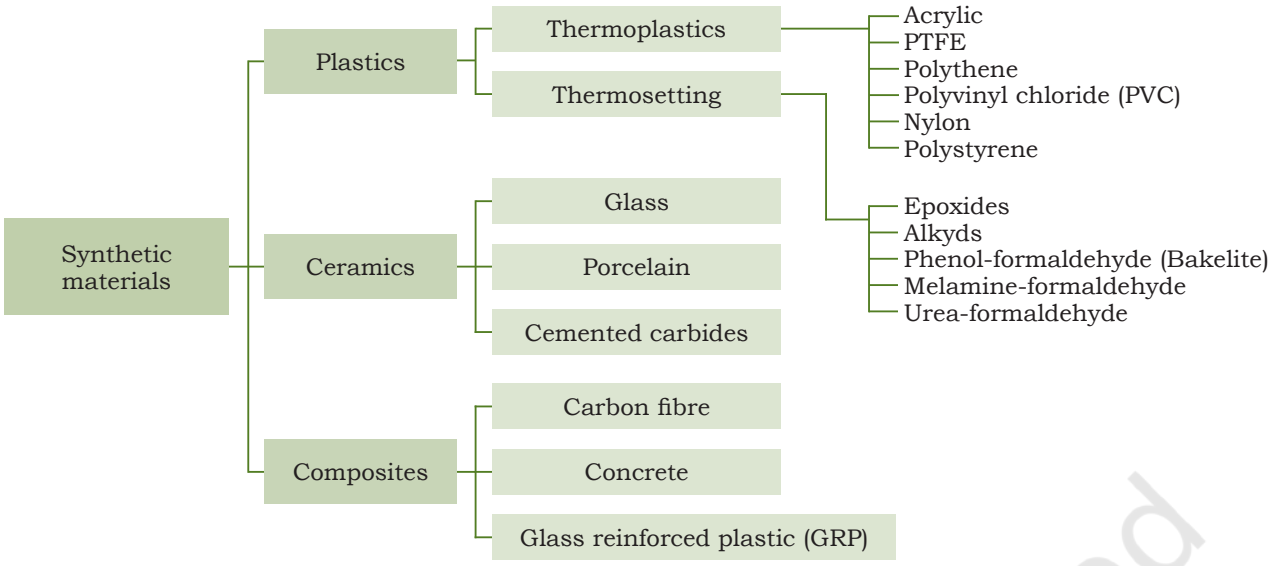


Fig. 3.6: Family of synthetic material

- It is light-weight, which leads to energy saving and subsequently lesser pollution.

In 1984, average new car contained 8.5% plastics by weight and today similar car contains around 11% plastics. The increased use of plastics reduces the mass of vehicles and consequently emissions. A quick look inside any model of the car may show that plastics are now used in both exterior and interior components, such as bumpers, doors, safety and windows, headlight and side-view mirror housing, trunk lids, engine intake manifolds, fuel tanks, steering wheels, interior door panels, built-in speaker baffles, door handles, wheel covers, dashboards, hoods, grills, gauges, dials, switches, air conditioner vents, floor mats, seat belts, airbags, wheel covers, etc. (Fig.3.7).

Fibre-reinforced plastic (FRP)

It is a composite material made of a polymer matrix reinforced with fibres. A mould is used to create the complete product (FRP), fiberglass is normally thermo set with a type of plastic or epoxy resin. When cured, the end product will hold its shape because of the resin, even as the fiberglass will provide strength and stiffness. FRPs are frequently used in the

Fig. 3.7: Use of plastic

Fig. 3.8: Rubber tyres

aerospace, automotive, marine, building industries and ballistic armor. It is used in bodies of racing cars to decrease weight, front show, inner windows, rear show, bumper, engine cover, etc.

Rubber

What's the common thing among all automobiles? They all require tyres. Rubber is impotent component and it used to manufacture various part such as special tyres, parts, wiper blades, engine mounts, seals, hoses and belts, etc. Automobile manufacturing is the base of the rubber industry, as about 75% of the world's usual rubber production is used to make tyres for vehicles. Compare with the plastic, it is very durable and cheap. Rubber is bendable material that has a wide uses in automobiles.

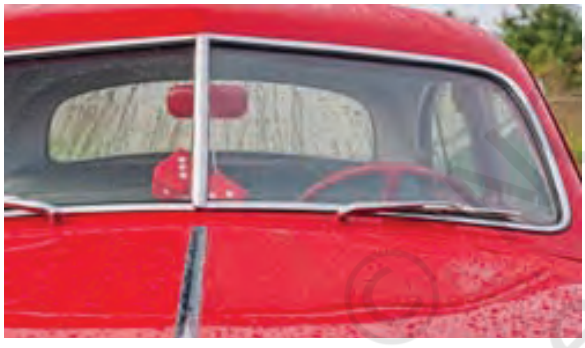


Fig. 3.9: Use of glass

Glass

Glass is used in a lot of areas of the vehicle. Obviously, its most important use is to create windshields so the driver can see properly while remaining safe from any airborne objects. It is also used to generate rear and side-view mirrors to boost view of what's around the driver while driving. However, as technology advances, glass is also being used to generate more innovative parts on vehicle. For example, it can be used to produce navigation screens and lenses for back-up cameras to allow drivers to have an even better view of what's in the wake of them.

Check Your Progress

A. Fill in the blanks

1. _____ and _____ contain high proportion of iron.
2. _____ is an alloy of carbon and iron.

3. Steels containing _____ to _____ carbon are called plain carbon steels.
4. Steels containing up to _____ carbon are called dead mild steel.
5. Blocks of many automobile and tractor assemblies are made of _____.

B. Multiple choice questions

1. Alloy steels containing up to 5% of total alloying elements are called _____.
   (a) low alloy steels
   (b) medium alloy steel
   (c) hard steel
   (d) None of the above
2. Mechanical properties of alloy steel, such as yield strength, ductility, are improved by _____.
   (a) alloying
   (b) welding
   (c) quenching
   (d) moulding
3. The material used to construct vehicle chassis and frames is _____.
   (a) carbon steel or aluminium alloys
   (b) iron or chromium
   (c) copper or steel
   (d) mould material
4. The fast cooling of iron with 2%–4.3 % carbon produces _____.
   (a) white cast iron
   (b) grey cast iron
   (c) hard iron
   (d) mild cast iron
5. When white cast iron cools down slowly, the resulting product is known as _____.
   (a) malleable cast iron
   (b) hard iron
   (c) grey iron
   (d) None of the above

C. Answer the following questions

1. Differentiate between glass and rubber.
2. Explain the role of plastic in automotive industry.

Session 2: Basic Manufacturing Processes

Manufacturing is the process of turning raw materials into finished products.

There are four types of manufacturing processes, which are as follows:

1. Casting
2. Forming
3. Joining
4. Machining

Casting

Casting is one of the oldest processes of manufacturing metallic components. In this process, a liquid material, which may be ferrous or non-ferrous, is poured into a moulding, and then allowed to solidity. Casting is done using various methods, which are as follows:

- Sand casting
- Shell casting
- Investment casting
- Full moulding
- Co_2 moulding

Fig. 3.10: Casting process

The mould is prepared from a refractory material like sand, etc. Fig.3.10 shows the casting process.

For bulky production of any design product, casting process is used. Important reasons for use of casting are stated here:

(a) Casting can create very composite geometry parts with hollow sections as well as cavities.

(b) It is used to construct from small to huge parts.

(c) In this process little wastage takes place and the extra metal may be re-used. It is economical as well.

Basic Casting Steps

The basic steps in making a casting are as follows:

1. Preparation of pattern and mould.
2. Melting and pouring the liquefied metal

3. Cooling and solidification of liquid metal
4. Inspecting the casting, refining and giving it final shape.

Applications of Casting Process

(a) Transport: Automobile—cylinder blocks, piston, piston ring, wheels, housing, etc.
(b) Machining and frames grind rolls,
(c) Water deliver and sewer pipes, sanitary fittings, door handles, locks, the outer casing or housing for motors, pumps and agricultural parts, etc. It is also used in the toy industry to build parts, for example, toy cars, planes, etc.

Machining

There are two types of machining processes:

- Conventional machining
- Unconventional machining

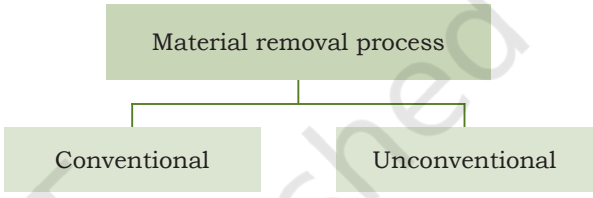


Fig. 3.11: Types of Machining

Machining is the process of cutting, shaping, or removing of material from a work piece using a machine tool.

During the manufacturing process, metal components and parts pass through machining process. Different materials like rubbers, plastic, paper goods are generally manufactured by machining processes.

All finished product meets the specifications as per engineering drawings. For example, a work piece may be required to have a specific outside diameter.

A lathe is an important machine tool used to reduce the diameter by rotating a metal piece. In this process, cutting tool cut metal and create a round surface as per the desired diameter and finish. A drill removes metal in the cylindrical shape of a hole. Various types of tools are used in milling machines for metal removal like saws, and grinding machines.

Machining Operations

Turning, drilling and milling are three important machining processes. Similarly, many operations like shaping; planning, boring, broaching and sawing are also part of machining operations.

- Turning is a type of machining or material removal process. In this process, a machine tool is used to create rotational parts by cutting away unwanted material. Lathes are the principal machine tool use in turning.
- Milling is material removal process. In this process a variety of features are created on a part by cutting away the undesired material. The milling does milling process. In milling, rotary cutters are used to remove material from a work piece.
- Drilling is a process of making a hole by oblique cutting. They are made by forging and are smaller in size so that there is some margin for reaming. Drilling is done primarily with a drill machine.
- Grinding is done to get the desired surface finish, correct size and accurate shape of product. Grinding wheel consists of abrasive particle, bonding material and voids. The abrasive surfaces act like cutting tool tips and remove the metal.

Lathe boring is a cutting operation that uses a boring head to enlarge an existing opening in a work piece. The expected accuracy of finish is +0.125mm.

Fig.3.12 shows some of the machine tools.

Drilling Machine Lathe Machine Milling Machine Grinding Machine

Fig. 3.12: Machine tools

Forming

Forming is the method in which the required size and shape are obtained through plastic deformation of a material. Aluminium or steel, coins, frame of doors and windows, springs, elevator doors, cables and wires, sheet-metal, etc., are made through the forming process.

Rolling

Rolling is a metal forming process. The process includes shape rolling, flat rolling, ring rolling, thread rolling, gear rolling, etc. In this process, a seamless tube and pipe are produced by rotary tube piercing or roll piercing. The material is drawn between the two revolving roll gaps by means of friction. All the sections of steels, such as channel, I-section, channel section, angle sections, flat iron, sheets, etc., are produced by the rolling process and many of them are used in developing vehicle chassis and body. Fig.3.13 shows a simple flat rolling process.

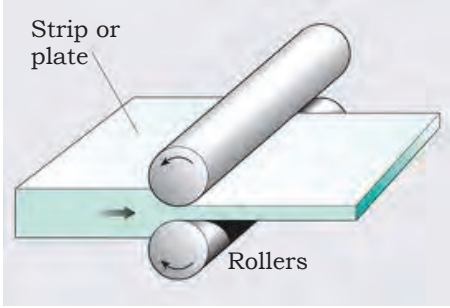


Fig. 3.13: Rolling process

Forging

When the metal is heated and a force is applied to metal to achieve final shape it is called forging.

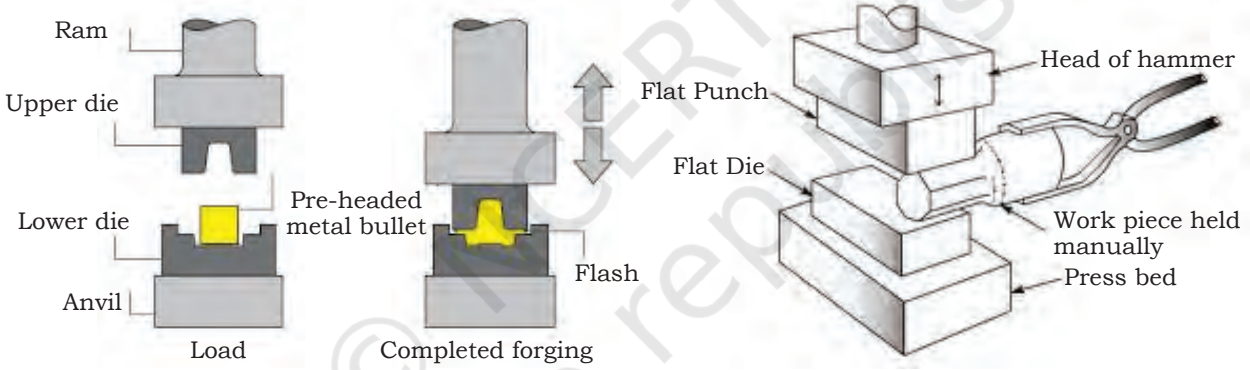


Fig. 3.14: Forging process

There are two types of forging—hot and cold. Auto components made using forging include crankshaft, camshaft, connecting rod, tie rod ends, ball joints, transmission gears, idler arms, drag links, rear axle shaft, propeller shaft components, steering cross assembly, clutch forks, water pump parts, etc. Fig.3.14 shows the forging process.

Extrusion

When a metal is extracted through a closed cavity to obtain a desired shape, it is known as extrusion. The shape of cross-sections can be solid round, rectangular,

L-shapes, T-shapes and tubes. Fig.3.15 shows the extrusion and extruded products.

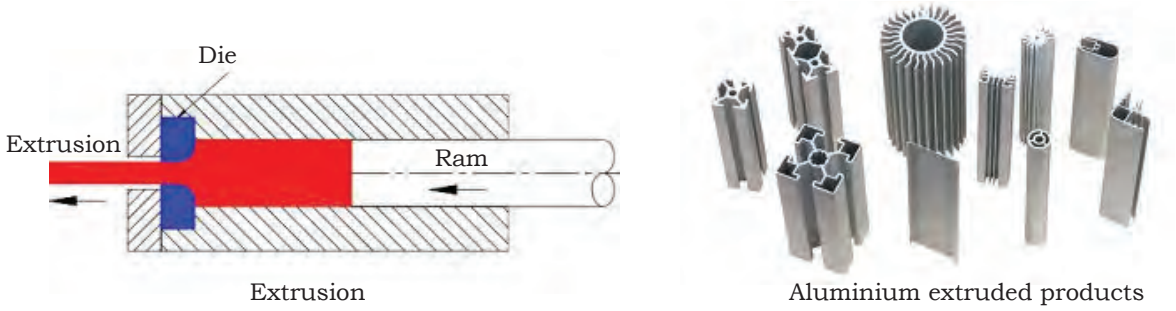


Fig. 3.15: Extrusion process

Drawing

It is a metal working process, which uses tensile forces to stretch metal or glass. As the metal is pulled through a dice then it stretches into a desired shape and thickness. Drawing process is used to make wire rods, tubes and sections.

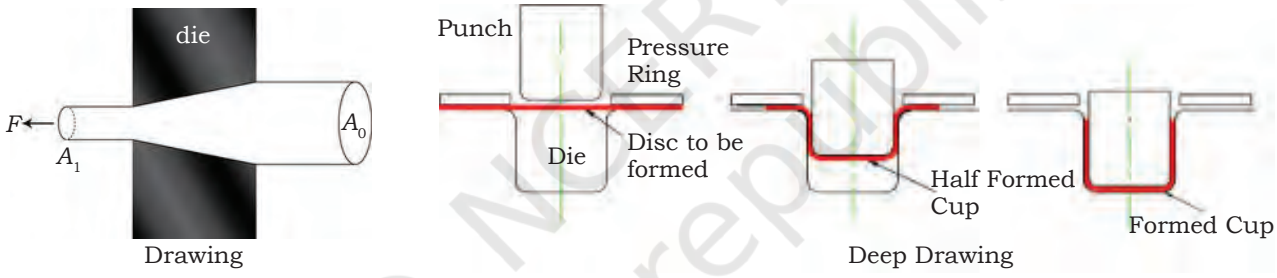


Fig. 3.16: Drawing process

Joining Processes

Joining processes are those processes that are used for joining metal parts and metal fabrication work. They are of four types: (a) Welding (b) Soldering (c) Brazing and (d) Adhesive Bonding.

Welding

Welding is the process of joining a similar and dissimilar material. In this process, two parts are joined together under heat or pressure with or without added metal. The welding process is divided into two categories, plastic welding or pressure welding and fusion welding or non-pressure welding, respectively.

Oxy-acetylene welding

Oxy-Fuel gas-Welding- is also called OFW. In this welding, Acetylene and oxygen gases are mixed; this generates very high temperatures of up to 3000°C. The flame helps in melting the metal at the joint, along with a filler rod to supply a number of additional materials to fill the gap. The flame is applied to the base metal and held until a small puddle of molten metal is formed. The oxy-acetylene welding process is shown in Fig.3.17. OFW is used to join mild steel permanently.

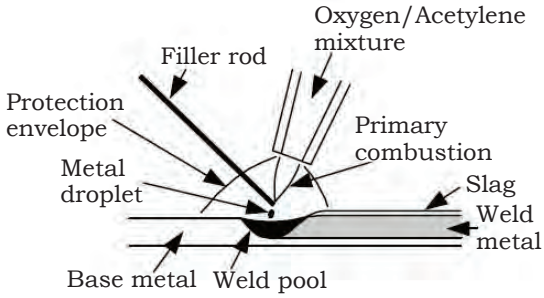


Fig. 3.17: Oxy-acetylene welding

Arc welding

Arc welding is one of the fusion processes for joining metals. In arc welding, intense heat is used to melt metal. Heat is produced by an electric arc. The arc is formed between the actual work and an electrode. This is also called the stick electrode welding procedure. Another name of this welding procedure is the coated electrode welding procedure. The usual diameter of the electrode is 2.5 to 6.35 mm, and the length of the electrode is 300 to 450 mm. Constant current type power source is used. First, the arc is generated in between the electrode and the work-piece. The temperature of the core and in between the arc is in the range of the 6000–7000 ˚C. If the movement of the arc or the electrode is controlled by machine, then it is called automatic arc welding. And if the first movement of the electrode is control by the machine then it is called as the semi-automatic machine. This welding can be done with both AC or DC type of current. Fig.3.18 shows an arc-welding circuit.

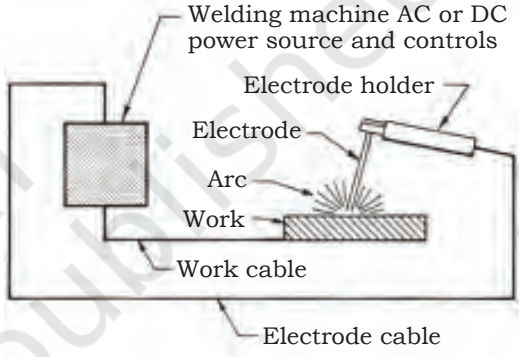


Fig. 3.18: Basic arc welding circuit

Check Your Progress

A. Fill in the blanks

1. Pouring of _____ into a mould is called casting.
2. The processing of raw material or parts into finished goods with the use of tool is called _____.

3. _____ is the process of removing undesired material from a work piece.
4. In milling _____ are used to remove material from a work piece.
5. _____ is done to get desired surface finish, correct size and accurate shape of product.

B. Multiple choice questions

1. In which method is the required size and shape obtained through plastic deformation of a material?
   (a) Forming
   (b) Machining
   (c) Honing
   (d) Welding
2. All the sections of steels, such as channel, I-section, channel section, angle sections, flat iron, sheets, etc., are produced by _____.
   (a) rolling
   (b) welding
   (c) moulding
   (d) casting
3. Auto components like crankshaft, camshaft, connecting rod, tie rod ends, ball joints, are prepared by _____.
   (a) forging
   (b) forming
   (c) extrusion
   (d) drawing
4. When a metal is extracted through a closed cavity to obtain desired shape of metal that process is called _____.
   (a) extrusion
   (b) forming
   (c) welding
   (d) moulding
5. The process of joining the similar and dissimilar material is called _____.
   (a) welding
   (b) drawing
   (c) casting
   (d) None of the above

C. Answer the following questions

1. Differentiate between rolling and forming.
2. Explain the different types of joining processes.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-3 SESSION-1

A. Fill in the blanks

1. _____ and _____ contain high proportion of iron.
2. _____ is an alloy of carbon and iron.
3. Steels containing _____ to _____ carbon are called plain carbon steels.
4. Steels containing up to _____ carbon are called dead mild steel.
5. Blocks of many automobile and tractor assemblies are made of _____.

B. Multiple choice questions

1. Alloy steels containing up to 5% of total alloying elements are called _____.
   (a) low alloy steels
   (b) medium alloy steel
   (c) hard steel
   (d) None of the above
2. Mechanical properties of alloy steel, such as yield strength, ductility, are improved by _____.
   (a) alloying
   (b) welding
   (c) quenching
   (d) moulding
3. The material used to construct vehicle chassis and frames is _____.
   (a) carbon steel or aluminium alloys
   (b) iron or chromium
   (c) copper or steel
   (d) mould material
4. The fast cooling of iron with 2%–4.3 % carbon produces _____.
   (a) white cast iron
   (b) grey cast iron
   (c) hard iron
   (d) mild cast iron

5. When white cast iron cools down slowly, the resulting product is known as _____.
   (a) malleable cast iron
   (b) hard iron
   (c) grey iron
   (d) None of the above

C. Answer the following questions

1. Differentiate between glass and rubber.
2. Explain the role of plastic in automotive industry.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-3 SESSION-2

A. Fill in the blanks

1. Pouring of _____ into a mould is called casting.
2. The processing of raw material or parts into finished goods with the use of tool is called _____.
3. _____ is the process of removing undesired material from a work piece.
4. In milling _____ are used to remove material from a work piece.
5. _____ is done to get desired surface finish, correct size and accurate shape of product.

B. Multiple choice questions

1. In which method is the required size and shape obtained through plastic deformation of a material?
   (a) Forming
   (b) Machining
   (c) Honing
   (d) Welding
2. All the sections of steels, such as channel, I-section, channel section, angle sections, flat iron, sheets, etc., are produced by _____.
   (a) rolling
   (b) welding
   (c) moulding
   (d) casting

3. Auto components like crankshaft, camshaft, connecting rod, tie rod ends, ball joints, are prepared by _____.
   (a) forging
   (b) forming
   (c) extrusion
   (d) drawing
4. When a metal is extracted through a closed cavity to obtain desired shape of metal that process is called _____.
   (a) extrusion
   (b) forming
   (c) welding
   (d) moulding
5. The process of joining the similar and dissimilar material is called _____.
   (a) welding
   (b) drawing
   (c) casting
   (d) None of the above

C. Answer the following questions

1. Differentiate between rolling and forming.
2. Explain the different types of joining processes.

Unit 4

Measuring Equipment

171169CH04

Measurement is assigning a value to length, mass and time. Whether building a motor or setting up a suspension, a mechanic heads to take accurate measurements to be able to make accurate adjustments, this unit will teach you about using measuring tools and making accurate measurements.

Instruments used for measuring basic units, such as mass, length and time or derived units, such as speed, acceleration, pressure, etc., are called measuring instruments or equipment.

It is important for an automotive technician to know which tool is the right one for the automotive part to be measured. This unit will cover the use of precision measuring equipment like gauges, etc., which are required for repair and maintenance of automobiles.

Session 1: Handling and Usage of Direct and Indirect Measuring Instruments

We all use some kind of measurement tools in our daily life. Similarly, the automotive industry also uses measurement equipment, which are important for determining the dimensions of any given object. Some examples of these tools are dial gauge, bore gauge, vernier caliper, depth gauge, micrometer, hydrometer and multi meter, etc. We will now try to understand the handling and usage of these measuring equipment.

Measuring Instruments

Measuring instruments used in the automotive industry can be classified as follows:

1. Linear measurement
   - Direct measuring instruments
   - Indirect instruments for transferring measurements
2. Angular measurement
3. Plane surface measurement

Direct Measuring Instruments

The instruments, which do not require the help of other instruments for measuring are called direct measuring instruments. Usually, these instruments have a line, which is divided in equal parts, called graduated scale. Some commonly used direct measuring instruments are:

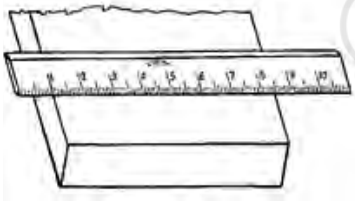


Fig. 4.1: Scale

Steel scale or rule

It is one of the simplest and most commonly used measuring device. A scale is made of a strip of hardened steel having line graduations marked at regular intervals. The length of a scale can be variable, it may be of either 150 mm long or 300 mm or 600 mm or 1000 mm long. Fig.4.1 shows a scale.

Fig. 4.2: Steel tape

Steel tape

A steel tape is made of steel or stainless steel. It is a flexible ruler to measure round curves or corners. A 2–3m length tape can be used in workshops. Fig.4.2 shows a steel tape.

Vernier caliper

It is an instrument used to measure internal and external distances precisely. The vernier caliper is generally a manual caliper, used in manufacturing for quality control. Fig.4.3 shows a vernier caliper.

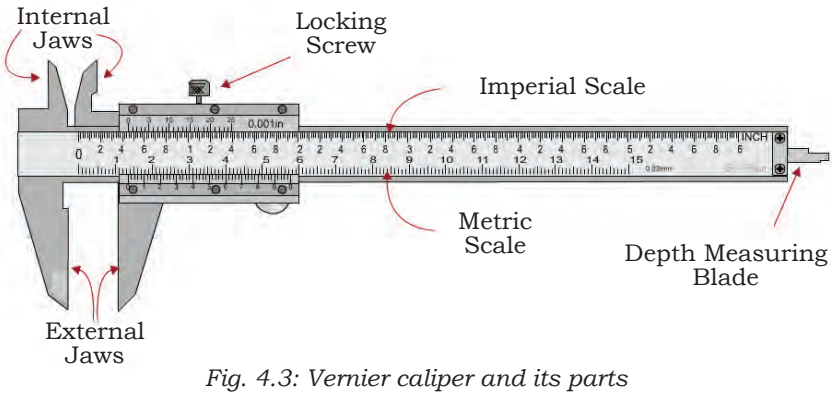


Fig. 4.3: Vernier caliper and its parts

Parts of a vernier caliper

- Outside jaws: used for measuring external length or width of an item.
- Inside jaws: measures the internal diameter of an object.
- Depth probe: computes the depths of an object or a hole.
- Main scale: scale marked in mm, inches and fractions.

A vernier caliper measure measurements upto 0.1 mm or more.

It also gives the result of measurements in fractions of an inch.

In a vernier caliper, the sliding jaw consists of the vernier scale, which moves over the main scale. When the two jaws come in contact, the main scale zero and the zero of the vernier scale must coincide. If both the zeros do not meet, there may be a positive or negative zero error.

The vernier scale has a main scale. On the vernier scale 0.9 cm is divided into ten equal parts. The least count or the smallest reading which we get with the instrument is calculated.

Least count = one main scale (MS) division – one vernier scale (VS) division.

Suppose 10 divisions of vernier scale = 9 division of main scale. Therefore, one division of vernier scale = 9/10 = 0.9 mm of main scale division (one division of main scale = 1 mm). Therefore, the least count will be

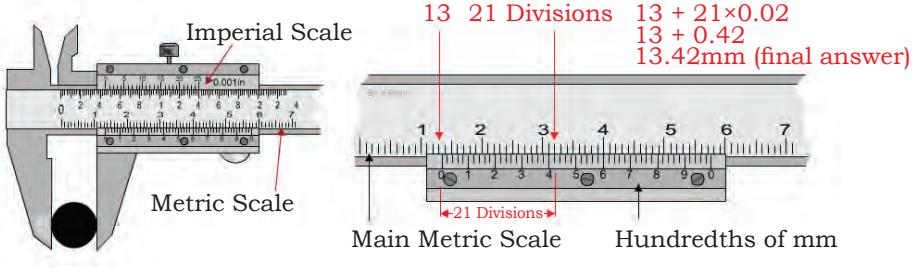
= 1 mm – 0.9 mm
= 0.1 mm
= 0.01 cm

Reading the vernier caliper and measuring the diameter of the cylinder

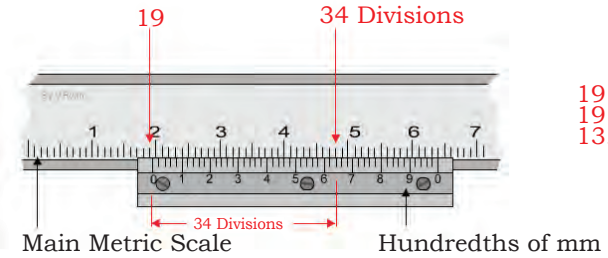
1. The sliding jaw is moved along the beam until it comes in contact with the cylinder kept against the fixed jaw. In this way the cylinder is held between the fixed and sliding jaw.
2. The sliding jaw assembly is clamped to the main beam with the help of a fine adjustment screw.
3. The knife edges of two jaws are now in contact with the cylinder.
4. The main slide assembly is then locked to the beam with the help of a retainer.
5. Remove the cylinder held in the jaws for reading the measurement or read the caliper when the cylinder is held in the jaws.
6. Read the main scale left to the zero of the vernier scale.
7. Read the vernier scale division, which coincides with the main scale division.
8. Multiply the reading of vernier scale with the least count and add it to the main scale reading to arrive at the final reading.

For example, 50 divisions on the vernier scale = 49 division on main scale. The value of one division on main scale is 1mm. Therefore, the least count = 1–49/50 = 0.02 mm

Example 1



Example 2



19 + 34×0.02
19 + 0.64
13.64mm (final answer)

Dial caliper

A dual caliper has a graduated scale and a dual indicator.

It consists of a small precise gear rack drive, which reads the reading.

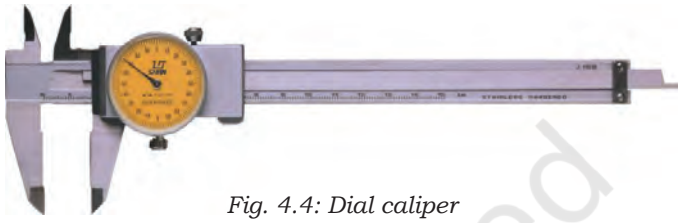


Fig. 4.4: Dial caliper

Digital caliper

It is an electronic digital caliper on which the reading is displayed as a single value. Digital calipers consist of 'reading hold' feature, which allow the reading of dimensions easily in awkward locations also.

Fig. 4.5: Digital caliper

Digital calipers are made of stainless steel. Digital calipers have an accuracy of 0.02mm and a resolution of 0.01mm.(Fig.4.5).

Vernier depth gauge

It is used for measuring distances from a plane surface to a projection, the depth of holes. In this depth gauge, the graduated scale can slide through the base and the vernier scale remains fixed. The reference surface on which the depth gauge base is rested should be flat and square in shape (Fig.4.6).

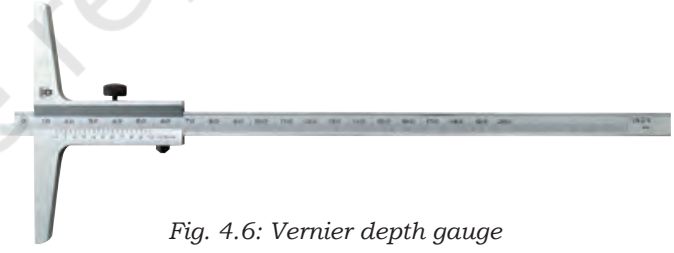


Fig. 4.6: Vernier depth gauge

Micrometer

It is a measuring instrument, used for inspecting and measuring the distance between two faces.

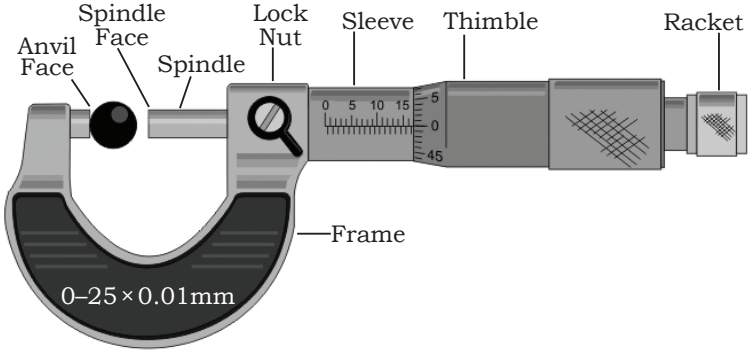


Fig. 4.7: Micrometer and its parts

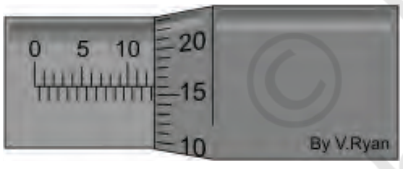
The object to be measured is kept between the spindle face and anvil face. Then the ratchet is rotated clockwise till the object is held between two surfaces and the ratchet makes a special noise. This indicates that the rachet cannot be tightened any further and the measurement should be read (Fig.4.7).

Calculation of least count of a micrometer
Least Count (L. C) = Pitch/No. of divisions on micrometer barrel (thimble) where, Pitch = distance travelled by thimble on a linear scale in one rotation, which is usually 0.5 mm, unless mentioned.

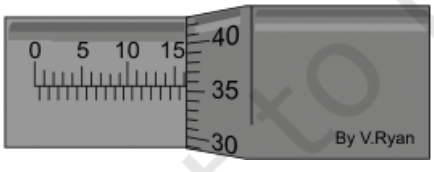
For example, the number of divisions on the barrel are 50. Therefore, the least count of the micrometer will be 0.5/50 = 0.01

1. Read the scale on the sleeve. The example shows 12 mm divisions.
2. Still reading the scale on the sleeve, a further ½ mm (0.5) measurement can be seen on the bottom half of the scale. The measurement now reads 12.5mm.
3. Finally, the thimble scale shows 16 full divisions (16 × 0.01 = 0.16 mm).

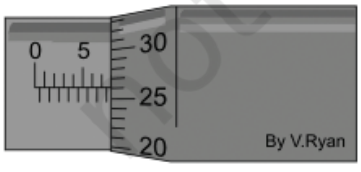
The final measurement is 12.5mm + 0.16mm = 12.66 mm



Sleeve Reads Full mm	=	12.00
Sleeve Reads ½ mm	=	0.50
Thimble Reads	=	0.16
Total Measurement	=	12.66 mm



Sleeve Reads Full mm	=	16.00
Sleeve Reads ½ mm	=	0
Thimble Reads	=	0.355
Total Measurement	=	16.355 mm



Sleeve Reads Full mm	=	7.00
Sleeve Reads ½ mm	=	0.50
Thimble Reads	=	0.26
Total Measurement	=	7.76 mm

Digital micrometer

The digital micrometer is shown is the figure and display the final reading. Micrometers are classified as per the

type of anvil and spindle faces such as gear tooth micrometer, sheet metal micrometer, etc.

Micrometer head is part of any measuring instrument which makes the instrument known with prefix as micrometer, such as micrometer depth gauge, micrometer bore gauge, etc. A digital micrometer is shown in Fig.4.8.

Fig. 4.8: Digital micrometer

Indirect Measuring Instruments

The simple calipers can be used in these situations. For measuring, the object is held between the ends, object removed and the ends are placed on steel scale to determine the distance. These calipers can be used to calculate the length, outside and inside diameters. Some of the calipers are as given below:

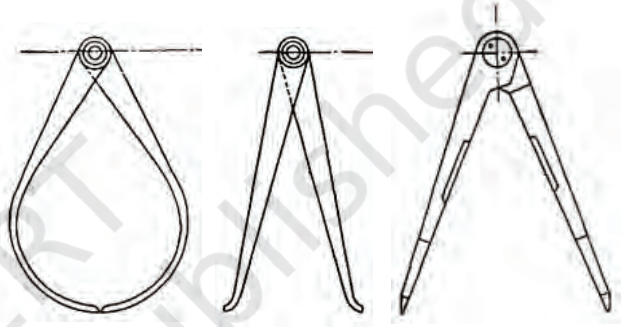


Fig. 4.9: Firm joint calipers: outside, inside and divider

Firm Joint Calipers

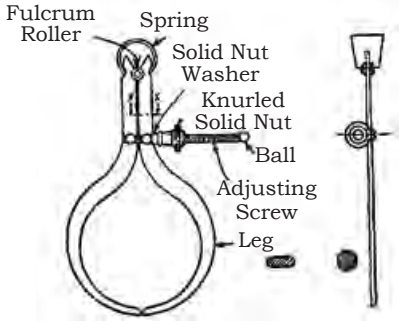
This device is used to compare measurements against known dimensions. It has two legs which are joined together by a rivet. The legs are set properly so that the working ends meet evenly and closely. The nominal sizes of joint caliper are 100 mm, 150 mm, 200 mm and 300 mm. Figure 4.9 shows different type of calipers.

Spring Joint Calipers

The functions of these calipers are similar to firm joint calipers. The legs of this caliper can be opened and closed by screwing the nut in and out of the bolt (Fig.4.10).

Measuring outside dimension

Checking inside groove



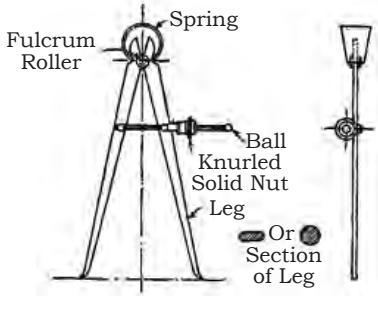


Fig. 4.10: Spring joint calipers: Outside and Inside

Practical Exercise

1. Make a list of direct and indirect measuring instruments.

S.No.	Name of instrument

2. Draw the line diagram of vernier caliper and micrometer, and label the parts.

Check Your Progress

A. Fill in the blanks

1. A _____ is assigning a value to length, mass and time.
2. The measuring instruments, which do not require the help of other _____ for measuring are called _____ measuring instruments.
3. Steel scale or rule is the _____ measuring tool.
4. The vernier caliper is a _____ tool used to measure _____ and external distances accurately.
5. In the vernier calliper the sliding jaw containing the _____ scale, moves over the main scale.
6. For measuring the depth of _____, recesses and _____ from a plane surface to a projection, the vernier depth gauge is employed.
7. The micrometer is a precision measuring instrument, used by engineers and technicians for _____ and measuring the distance between two _____.
8. The digital micrometer the _____ reading.

B. Multiple choice questions

1. Direct measuring instruments have a line, which is divided in equal parts, called _____.
   (a) graduated scale
   (b) firm joint calipers
   (c) spring joint meter
   (d) All of the above
2. Which measuring instrument is used to measure internal and external distances precisely?
   (a) Vernier caliper
   (b) Spring joint meter
   (c) Micrometer
   (d) None of the above
3. The least count or the smallest reading which we get with the vernier caliper is calculated as _____.
   (a) 0.01 cm
   (b) 0.001 m
   (c) 0.0001 cm
   (d) None of the above
4. Digital calipers are made of _____.
   (a) stainless steel
   (b) iron
   (c) copper
   (d) aluminium
5. Which devices are used for comparing measurements against known dimensions?
   (a) Firm joint calipers
   (b) Spring joint callipers
   (c) Micrometer
   (d) None of the above

C. Answer the following questions

1. Give the importance of measuring instruments.
2. What is the difference between direct and indirect measuring instruments?
3. Explain the procedure for determining the least count of vernier caliper.
4. How do you determine the least count of micrometer?
5. How do we measure using indirect measuring instruments?
6. Differentiate between vernier and digital caliper.
7. Which parameters can be measured with vernier depth gauge?

Fig. 4.11: Protractor

Fig. 4.12: Blade protractor

8. What are the various alert signs found in a dashboard of a vehicle?
9. Take any object round or square. Measure and write the reading with the help of vernier caliper in the table given below.

S. No	Main Scale Reading(A)	Vernier Scale Reading(B)	Least Count (C)	Least Count x Vernier Scale (BxC=D)	Actual Reading (A+D)

Session 2: Angular Measuring Instruments

Instruments used for measuring angles are called angular measuring instruments. Angular measuring instruments include the following:

Protractor

It is a device used for measuring the angle between two intersecting lines (Fig.4.11). The angle is measured in degrees.

Blade Protractor

It is a tool used for setting bevels, transferring angles, small squaring tasks, and many other applications (Fig.4.12).

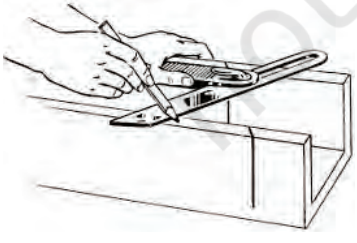


Fig. 4.13: Bevel gauge and its use

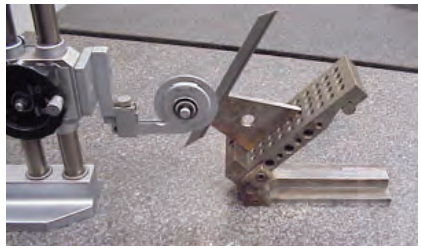
Bevel or Combination Gauge

A bevel gauge is also called an adjustable gauge. It is used for setting and transferring angles. The handle is made of wood or plastic or steel and is attached to a metal blade with a thumb screw or wing nut. The blade pivots can be locked at any angle by loosening or tightening the thumb screw. The bevel gauge and its applications are shown in Fig.4.13.

A gauge is used for measuring the angle of valve face and valve seat. The straight edge is used to check the distortion of plain surfaces like the cylinder head and cylinder block.

Measuring acute angles

Measuring obtuse angles



Protractor with a vernier height gauge

Fig. 4.14 (a)

Universal Protractor

The universal bevel protractor (Fig. 4.14 [a & b]) is used for precision measuring and layout of obtuse angles as well as acute angles. It consists of a main scale and vernier scale.

The main scale is an important component of the bevel protractor and consists of number from 0 to 90 degrees and then back from 90 degrees to 0 (Fig.4.15). Four 90-degree components are graduated in the main scale.

Similarly, with vernier measuring devices, the vernier scale is divided into 24 spaces, 12 spaces on either side of the zero. Each space on the vernier scale is, therefore, one-twelfth of a degree. And one-twelfth of a degree is equal to 5 minutes.

For reading the protractor, the zero on the vernier scale lines up with the degrees on the dial (Fig.4.15). The degrees are read directly from the main scale. The zero on the vernier scale is just after the 85 degree mark. Now, read in the same direction (counter-clockwise), count, by five, from zero on the vernier scale to the lines that match up on the dial (Fig.4.16).

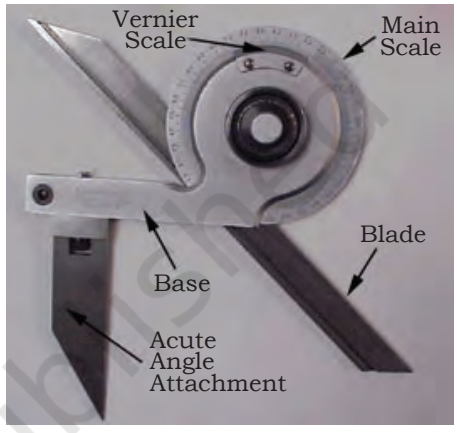


Fig. 4.14 (b): The universal bevel protractor is capable of measuring 1/ 12 of a degree.

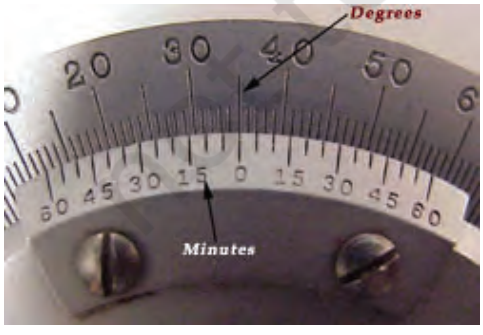


Fig. 4.15: Degrees can be read directly off the main scale, while the minutes are read on the vernier scale.

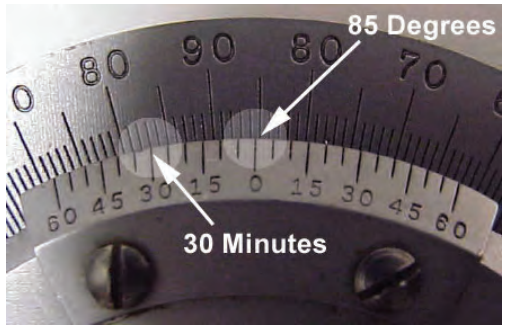


Fig. 4.16: Always read the vernier in the same direction that you read the dial

Add this number of minutes to the number of whole degrees. The total number of degrees and minutes in Fig.4.16 would equal 85 degrees and 30 minutes. See the measurements in the figure to get the correct vernier bevel protractor reading.

Practical Exercise

1. Make a list of angular measuring instruments.

S.No.	Name of instrument

2. Draw the line diagrams of angular measuring instruments and label the parts.

Check your Progress

A. Fill in the blanks

1. Instruments used for measuring the angle are called _____ measuring instruments.
2. A protractor is a device for measuring the angle between two _____ lines.
3. The blade protractor has double graduations from 0–180° in _____ directions permitting the direct reading of angles.
4. A bevel gauge is a (an) _____ gauge for setting and _____ angles.
5. The universal bevel protractor is designed for _____ measuring and _____ of angles.

B. Multiple choice questions

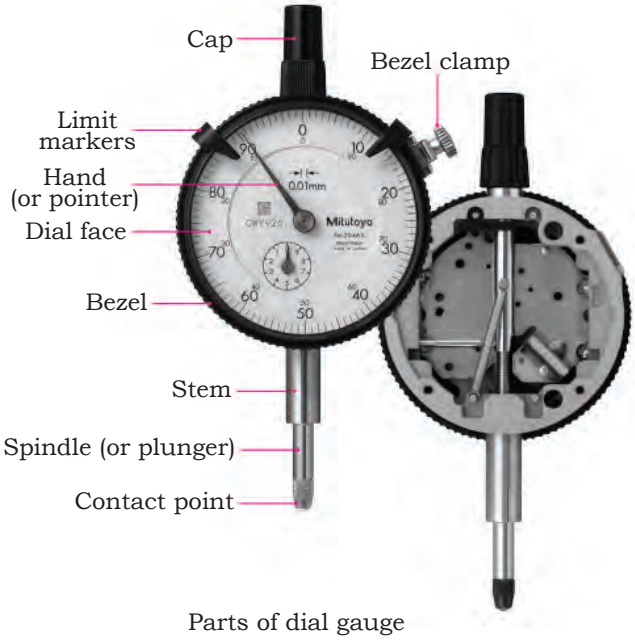
1. Instruments used for measuring angles are called _____.
   (a) angular measuring instruments
   (b) gauge
   (c) micrometer
   (d) None of the above
2. Which device is used for measuring the angle between two intersecting lines?
   (a) Protractor
   (b) Scale
   (c) Caliper
   (d) Screw-gauge
3. Bevel or combination gauge is used to measure _____.
   (a) setting and transferring angles
   (b) depth
   (c) length
   (d) accurate angle
4. Which device is used for precision measuring and layout of angles?
   (a) Universal Protractor
   (b) Combination gauge
   (c) Caliper
   (d) None of the above

C. Answer the following questions

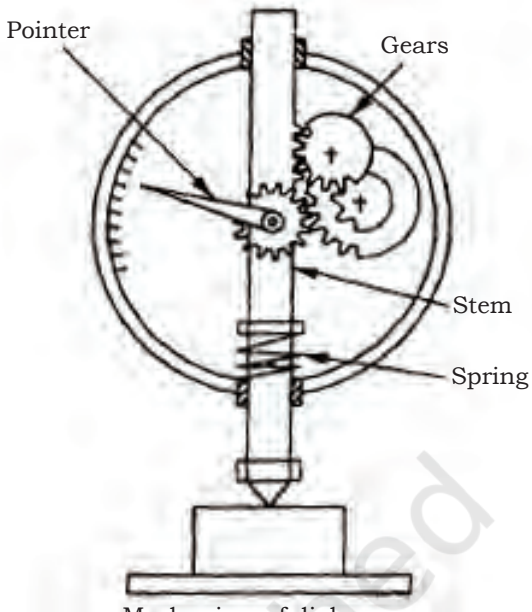
1. Explain the importance of angular measurement and measuring instruments.
2. What is the difference between a protractor and blade protractor?
3. Explain the procedure for using a bevel gauge.
4. How do we determine the least count of universal bevel protractor?

SESSION 3: DIAL INDICATOR OR GAUGE AND OTHER GAUGES

A dial gauge (Fig. 4.17) is like a fine watch. It consists of a graduated dial, pointer, plunger and a clamp. It measures the displacement of its plunger on a circular dial by means of a rotating pointer. It is a measuring device that measures the accuracies in alignment and



Parts of dial gauge



Mechanism of dial gauge

Fig. 4.17: Dial gauge

eccentricity of the parts or components. Dial indicators are also great for checking crankshaft runout, crank end play, shaft thrust, gear backlash, flywheel face runout, flywheel housing concentricity, valve seat concentricity or piston deck clearance.

It works on the rack and pinion principle. The stem or plunger has rack teeth. A set of gears engage with the rack. The pointer is connected to a small pinion. This small pinion is independently hinged, i.e., it is not connected to the stem. The vertical movement of the stem is transmitted to the pointer through a set of gears. A spring gives a constant downward pressure to the stem.

Thus, any movement of the plunger causes a corresponding movement of the main pointer on a graduated dial. In addition to the main pointer the dial gauge has a secondary scale and a small pointer for indicating the number of revolutions made by the main pointer. Zero setting of the main pointer of the dial gauge can be done by rotating the dial face until '0' line coincides with the pointer. For use, a dial gauge is attached to the magnetic mounting stand (Fig.4.18) and the base of the stand is held on a flat surface.

Fig. 4.18: Dial gauge mounting stand

The contact point of the stem is brought in contact with the part to be inspected. The part is rotated or translated and deviations in readings are observed on the dial face with the movement of pointer.

Digital Dial Indicator or Gauge

Its use is similar to a dial indicator or gauge and it uses an inductive measuring system and has LCD display. It has on/off function, zero setting at any position, hold function and plus-minus preset function. It is also used in conjunction with a magnetic base stand. The reading is displayed on the dial (Fig.4.19).

Fig. 4.19: Digital dial gauge

Telescopic Gauge

A telescopic gauge is a measuring tool with spring-loaded plungers used together with a micrometer to measure the inside of holes or bores. Telescopic are used to measure a bore's size, by transferring the internal dimension to a remote measuring tool. It is equivalent to inside calipers and the user gets the correct feel of repeatable results. Telescopic gauge is also used to find out the internal diameter of pipe, cylinder bore and slots. A telescoping gauge can be positioned inside holes or openings and then extended to touch the walls. They are made as insets to measure from small to very large bores (Fig.4.20).

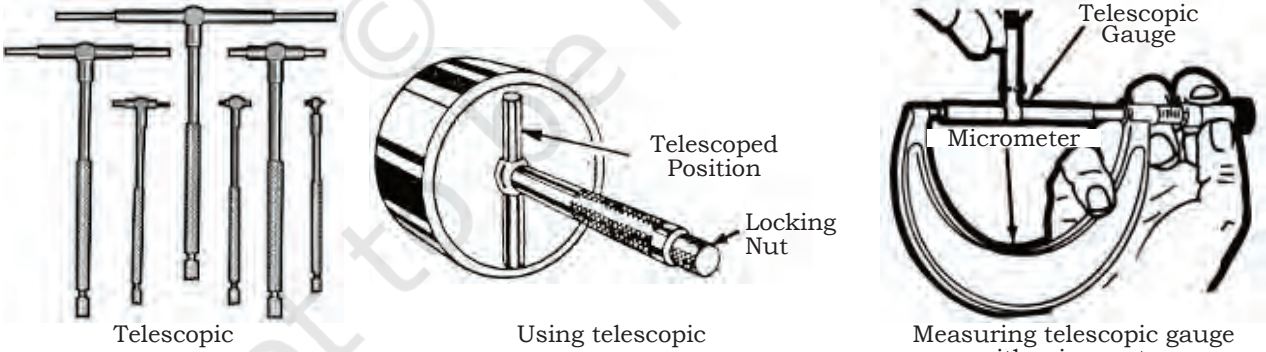


Fig. 4. 20: Telescopic gauge and applications

Measuring diameter of bore with telescopic gauge

- Select appropriate size of telescopic gauge according to the bore.
- Press the plungers in the barrel and lock the ratchet.

- Place the gauge in a cylinder bore to check internal diameter.
- Turn the ratchet, the spring loaded plungers will come out and touch the side of the bore and exert equal pressure on both side of the cylinder wall. However, ensure that the gauge is held with the telescoping end at right angles to the axis of the hole to measure the true, maximum diameter.
- Rock the gauge back and forth to be sure it is square in the bore and the gauge parallel to the ground.
- Lock the telescopic gauge, plunger remains open and occupies the internal diameter.
- Slowly remove the telescopic gauge from the bore and measure across the two ends of the plungers with an outside micrometer.
- This gives main reading of cylinder bore.

Bore Gauge

A bore gauge measures a bore directly.

Dial bore gauge

It is a special tool, which is used to accurately measure the inside diameter of a hole, cylinder or pipe (Fig.4.21). It also detects ovality and tapers in bores. Dial bore gauges do the checking for taper or out-of-round conditions in a cylinder bore. Bore gauge measures the exact reading of a bore size. It consists of a shaft with a dial indicator at the top and a measuring sled at the base. The measuring sled consists of three guides and an actuating plunger. Dial bore gauges measure quick and accurate readings.

Fig. 4.21: Dial bore gauge

Measuring the bore size with Dial Bore Gauge

1. Zero the dial bore gauge against a calibrated ring of the same relative size as the bore.
2. Insert the head of the gauge into the bore following the tool's operating instructions. Rock the tool back and forth gently in the bore once the gauge is inserted and standing upright.
3. Watch the readout on the dial face as you rock the gauge back and forth. Record the value of the largest deviation away from '0' on the dial face.

Record the deviation as a positive number if it falls to the right of "0" and a negative number if it falls to the left of "0".

4. Look at the reading. This is the lowest reading, which is taken when the gauge is square on the bore, and the indicator needle reverses its direction. It can be either more or less than the zero mark, and will indicate an oversized or undersized bore.
5. Add or subtract the value of the largest deviation from the calibrated value of the bore gauge. If the gauge was zeroed at 100 mm, and the largest deviation a 0.5 mm to the right of the '0' on the dial face, then the final measurement of the bore is 100.5 mm. Alternatively, if the largest deviation was 0.5 mm to the left of the '0' on the dial face of a gauge calibrated to 100 mm, then the final measurement of the bore is 99.5 mm. Fig.4.22 and 4.23 shows a dial bore gauge.

Fig. 4.22: Using bore gauge showing measuring sled

Fig. 4.23: Micrometer bore gauge

Precautions

Clean the hole to be measured and ensure that it is free of oil, grease or particles before introducing a precision measuring tool into the hole.

Never force precision measuring tools. Permanent and expensive damage may result and the tool will likely be ruined. Avoid shocks to the tool, such as dropping it or hitting it.

Screw Pitch Gauges

These devices are used to check the pitch of the thread immediately. It is necessary that everyday tool should be used to pick out a desired screw. The number of flat blades with different pitches is pivoted in a holder. The pitch value is marked on each blade. To know the pitch of any thread (nut, bolt, etc.), by visual inspection, the leaf is selected and placed on the profile of the thread. If the profile of screw pitch gauge leaf matches with the profile of the thread being inspected, the value of pitch is read from the leaf. If the profile does not match, another leaf is selected and the process repeated till the profiles match. It must be ensured that during matching, air or

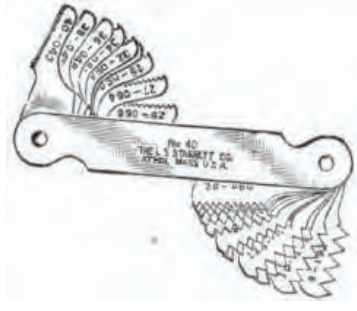


Fig. 4.24: Screw pitch gauge

Fig. 4.25: Feeler gauge

light should not pass through the profiles. The screw pitch gauge is shown in Fig.4.24.

Feeler Gauges

These gauges are used for checking the clearance between mating surfaces. They are mainly used in adjusting the valve clearance and setting of spark plug gaps in automobiles. They are made from 0.03 to 1.0mm thick of 100mm long leaves. The blades are pivoted in a holder. The value of thickness of the leaf is marked or engraved on it. To know or adjust the clearance or gap, the leaf of the feeler gauge is selected and inserted in the gap. The leaf should not be loose or inserted with force. The leaf should go in the gap with slight drag or resistance. The value of the clearance or gap is read from the leaf of feeler gauge (Fig.4.25).

Practical Exercise

1. Various types of gauges are used for checking components of automobile. Make a list of these gauges.

S.No.	Name of gauge

2. Draw and show the working principle of dial gauge and label the parts.

Check Your Progress

A. Fill in the blanks

1. Dial gauge is used as a measuring device to measure the accuracies in _____, _____ of the parts or components.

2. Dial gauge works on the _____ and _____ principle.
3. A telescoping gauge is a measuring tool with spring-loaded _____ used together with a _____.
4. A vernier bore gauge measures a _____ directly.
5. A dial bore gauge is a special tool, which is used to accurately measure the inside _____ of a hole, cylinder or pipe and detect _____ and tapers in bores.
6. Screw pitch gauges are used to check the _____ of the thread immediately.
7. Feeler gauges are used for checking the clearance between _____ surfaces.

B. Multiple choice questions

1. Which of these is not a part of dial indicator?
   (a) graduated dial
   (b) pointer
   (c) plunger
   (d) lamp
2. A dial indicator or gauge works on which principle?
   (a) Rack and pinion
   (b) Torque
   (c) Moving
   (d) Helix
3. Which device is used to measure a bore's size?
   (a) Telescope Gauge
   (b) Bore Gauge
   (c) Comparator
   (d) Micrometer

C. Answer the following questions

1. What is the importance of a dial indicator or gauge?
2. Explain the working principle of a dial gauge.
3. What is a feeler gauge?
4. List the steps required to measure the bore of an object with the help of a dial bore gauge.
5. What is a screw pitch gauge? Give its application.

Session 4: Instruments on the Dashboard of a Vehicle

A dashboard is like a control panel placed in front of the driver. The dashboard has a cluster of instruments and

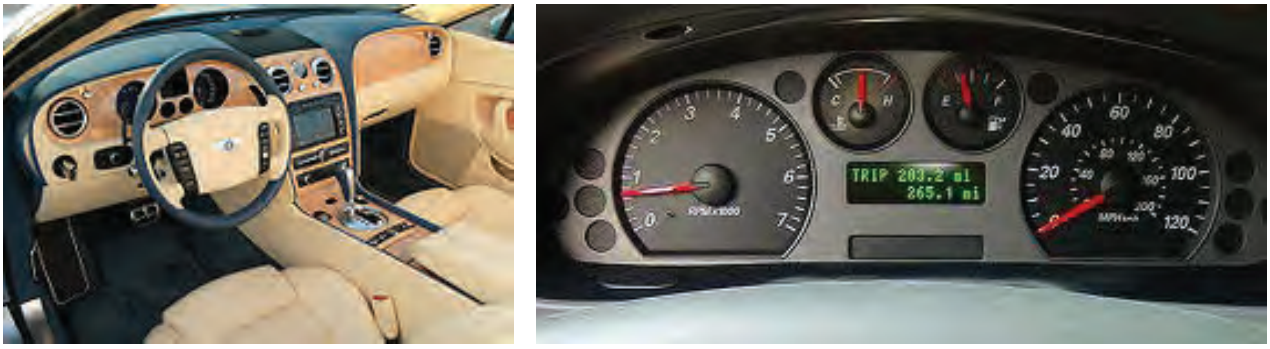


Fig. 4.26: Dash board and instrument panel of a vehicle

gauges, such as speedometer, tachometer, odometer and fuel gauge, and indicators, such as gearshift position, seat belt warning light, parking-brake-engagement warning light and an engine-malfunction light, which convey the health of vehicle to the driver. It also has indicators for low fuel, low tyre pressure, low oil pressure, and faults in the airbag (SRS) system, ventilation controls, lighting controls, audio equipment and automotive navigation systems, mounted on the dashboard. The top of a dashboard generally contains vents for an air conditioning and heating system and speakers for an audio system, a compartment is commonly located on the passenger's side for keeping gloves, etc. An ashtray, a power outlet for low-voltage appliances is also fitted.

Fig. 4.27: Speedometer

Fig. 4.28: Tachometer

Important Components of Dashboard

Every component fitted in dashboard indicates working of particular section. The important components of a dashboard are as follows:

Speedometer

The speedometer indicates the speed of a vehicle. Speed is measured in kilometers per hour. The control of vehicle rests with the driver, therefore, the speedometer helps the driver to keep the speed in safe limit. Fig.4.27 shows speedometer.

Tachometer

Tachometer (Fig.4.28) indicates how fast the engine is turning in revolutions per minute (rpm).

A driver should avoid running the engine in 'danger zone'. If the driver notices that the tachometer is reading abnormally high on accelerating, it indicates problems and the need to get the vehicle checked at service station.

Fig. 4.29: Odometer

Odometer

An odometer (Fig.4.29) is a tool that shows the distance travelled by a vehicle. The device may be electronic, mechanical, or a combination of both.

Fig. 4.30: Fuel gauge

Fuel gauge

The fuel gauge (Fig.4.30) informs about the status and amount of fuel in the tank of vehicle. It should be regularly checked to avoid being stranded on road.

Fig. 4.31: Temperature gauge

Temperature gauge

The temperature gauge of a vehicle (Fig.4.31) measures the temperature of the engine's coolant. Most gauges measure temperature ranges. If a vehicle's temperature gauge is in the hot range, it needs to be moved to a safe place and stopped immediately.

When temperatures are consistently above the vehicle's normal range, it could indicate trouble with the cooling system.

Fig. 4.32: MIL-Service Engine Soon

Malfunction indicator lamp

It is also known as a check engine light, which indicates malfunction of a computerised engine management system. It can be seen on the instrument panel of most automobiles. When the MIL is on, the engine control unit stores a fault code related to the malfunction, which is checked with a scan tool and it is used for further diagnosis. The malfunction indicator lamp informs a driver through signal, such as check engine, service engine soon, or a pictogram of an engine (Figs.4.32 and 4.33).

Fig. 4.33: MIL-Check Engine

In most cases, the light is not a sign of anything serious, due to which a lot of people ignore it. This may leads to problems in a vehicle and cause further damage.

Fig. 4.34: Navigator

Automotive navigation system

It is a satellite navigation system developed for use in automobiles. This system uses a GPS navigation device (Fig.4.34) to collect position data to locate the user on a road in the unit's map database. With the help of road database, the unit can inform about directions to other locations along roads, also present in its database. This unit can be fitted in dashboard of vehicle.

Driver information system (DIS):

Nowadays, most of the vehicles are fitted with DIS System. This system informs the driver about spontaneous fuel consumption, range of travel, available quantity of fuel in terms of kilometer, digital watch with atmospheric temperature.

Practical Exercise

1. List the important instruments which are fitted on the dashboard of a vehicle.

S.No.	Name of instrument

2. Draw the diagram of a dashboard with different instruments and components fitted on it and also label them.

Check Your Progress

A. Fill in the blanks

1. The speedometer tells the driver about the _____ of a vehicle.
2. Tachometer tells how fast engine is turning in _____ _____.
3. An odometer is an instrument that informs about the _____ travelled by a vehicle.
4. The fuel gauge informs about the status of the _____ of fuel in the vehicle tank.
5. The temperature gauge measures the temperature of an engine's _____.
6. An automotive navigation system is a _____ system suitable for use in automobiles.

B. Multiple choice questions

1. Which of these is not a component of the dashboard?
   (a) Speedometer
   (b) Tachometer
   (c) Odometer
   (d) Chassis
2. Speedometer measures the speed in _____.
   (a) kilometres per hour
   (b) centimetres per hour
   (c) meters per hour
   (d) None of the above
3. Which of these devices are used to show the distance travelled by a vehicle?
   (a) Tachometer
   (b) Odometer
   (c) Speedometer
   (d) All of the above

C. Answer the following questions

1. What information is given by the speedometer?
2. What information is given by the odometer?
3. What is the use of a navigation system in vehicles?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-4 SESSION-1

A. Fill in the blanks

1. A _____ is assigning a value to length, mass and time.
2. The measuring instruments, which do not require the help of other _____ for measuring are called _____ measuring instruments.
3. Steel scale or rule is the _____ measuring tool.
4. The vernier caliper is a _____ tool used to measure _____ and external distances accurately.
5. In the vernier calliper the sliding jaw containing the _____ scale, moves over the main scale.
6. For measuring the depth of _____, recesses and _____ from a plane surface to a projection, the vernier depth gauge is employed.
7. The micrometer is a precision measuring instrument, used by engineers and technicians for _____ and measuring the distance between two _____.
8. The digital micrometer the _____ reading.

B. Multiple choice questions

1. Direct measuring instruments have a line, which is divided in equal parts, called _____.
   (a) graduated scale
   (b) firm joint calipers
   (c) spring joint meter
   (d) All of the above
2. Which measuring instrument is used to measure internal and external distances precisely?
   (a) Vernier caliper
   (b) Spring joint meter
   (c) Micrometer
   (d) None of the above
3. The least count or the smallest reading which we get with the vernier caliper is calculated as _____.
   (a) 0.01 cm
   (b) 0.001 m
   (c) 0.0001 cm
   (d) None of the above

4. Digital calipers are made of _____.
   (a) stainless steel
   (b) iron
   (c) copper
   (d) aluminium
5. Which devices are used for comparing measurements against known dimensions?
   (a) Firm joint calipers
   (b) Spring joint callipers
   (c) Micrometer
   (d) None of the above

C. Answer the following questions

1. Give the importance of measuring instruments.
2. What is the difference between direct and indirect measuring instruments?
3. Explain the procedure for determining the least count of vernier caliper.
4. How do you determine the least count of micrometer?
5. How do we measure using indirect measuring instruments?
6. Differentiate between vernier and digital caliper.
7. Which parameters can be measured with vernier depth gauge?
8. What are the various alert signs found in a dashboard of a vehicle?
9. Take any object round or square. Measure and write the reading with the help of vernier caliper in the table given below.

S. No	Main Scale Reading(A)	Vernier Scale Reading(B)	Least Count (C)	Least Count x Vernier Scale (BxC=D)	Actual Reading (A+D)

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-4 SESSION-2

A. Fill in the blanks

1. Instruments used for measuring the angle are called _____ measuring instruments.
2. A protractor is a device for measuring the angle between two _____ lines.
3. The blade protractor has double graduations from 0–180° in _____ directions permitting the direct reading of angles.
4. A bevel gauge is a (an) _____ gauge for setting and _____ angles.
5. The universal bevel protractor is designed for _____ measuring and _____ of angles.

B. Multiple choice questions

1. Instruments used for measuring angles are called _____.
   (a) angular measuring instruments
   (b) gauge
   (c) micrometer
   (d) None of the above
2. Which device is used for measuring the angle between two intersecting lines?
   (a) Protractor
   (b) Scale
   (c) Caliper
   (d) Screw-gauge
3. Bevel or combination gauge is used to measure _____.
   (a) setting and transferring angles
   (b) depth
   (c) length
   (d) accurate angle
4. Which device is used for precision measuring and layout of angles?
   (a) Universal Protractor
   (b) Combination gauge
   (c) Caliper
   (d) None of the above

C. Answer the following questions

1. Explain the importance of angular measurement and measuring instruments.
2. What is the difference between a protractor and blade protractor?
3. Explain the procedure for using a bevel gauge.
4. How do we determine the least count of universal bevel protractor?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-4 SESSION-3

A. Fill in the blanks

1. Dial gauge is used as a measuring device to measure the accuracies in _____, _____ of the parts or components.
2. Dial gauge works on the _____ and _____ principle.
3. A telescoping gauge is a measuring tool with spring-loaded _____ used together with a _____.
4. A vernier bore gauge measures a _____ directly.
5. A dial bore gauge is a special tool, which is used to accurately measure the inside _____ of a hole, cylinder or pipe and detect _____ and tapers in bores.
6. Screw pitch gauges are used to check the _____ of the thread immediately.
7. Feeler gauges are used for checking the clearance between _____ surfaces.

B. Multiple choice questions

1. Which of these is not a part of dial indicator?
   (a) graduated dial
   (b) pointer
   (c) plunger
   (d) lamp

2. A dial indicator or gauge works on which principle?
   (a) Rack and pinion
   (b) Torque
   (c) Moving
   (d) Helix
3. Which device is used to measure a bore's size?
   (a) Telescope Gauge
   (b) Bore Gauge
   (c) Comparator
   (d) Micrometer

C. Answer the following questions

1. What is the importance of a dial indicator or gauge?
2. Explain the working principle of a dial gauge.
3. What is a feeler gauge?
4. List the steps required to measure the bore of an object with the help of a dial bore gauge.
5. What is a screw pitch gauge? Give its application.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-4 SESSION-4

A. Fill in the blanks

1. The speedometer tells the driver about the _____ of a vehicle.
2. Tachometer tells how fast engine is turning in _____ _____.
3. An odometer is an instrument that informs about the _____ travelled by a vehicle.
4. The fuel gauge informs about the status of the _____ of fuel in the vehicle tank.
5. The temperature gauge measures the temperature of an engine's _____.
6. An automotive navigation system is a _____ system suitable for use in automobiles.

B. Multiple choice questions

1. Which of these is not a component of the dashboard?
   (a) Speedometer
   (b) Tachometer
   (c) Odometer
   (d) Chassis

2. Speedometer measures the speed in _____.
   (a) kilometres per hour
   (b) centimetres per hour
   (c) meters per hour
   (d) None of the above
3. Which of these devices are used to show the distance travelled by a vehicle?
   (a) Tachometer
   (b) Odometer
   (c) Speedometer
   (d) All of the above

C. Answer the following questions

1. What information is given by the speedometer?
2. What information is given by the odometer?
3. What is the use of a navigation system in vehicles?

Unit 5

Regular Maintenance of an Engine

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Driving a car can be fun, but its maintenance is also important. A planned preventive maintenance regime can reduce running costs and prolong the life of a vehicle.

Changing the engine oil and filter on a regular basis is the most important step for maintenance. The additives in the engine oil get exhausted with time and may lead to heating up of engine and cause damage.

Pumping up and maintaining the tyre pressure is also another important step. Insufficient air in tyres can cause wearing and overjelling can cause bursting of tyres. Therefore, recommended inflation pressure should be considered while filling air in tyres.

In this unit we will understand the importance of maintenance of a vehicle.

Fig. 5.1: Engine

Session 1: Inspection of an Engine

When it comes to a car, the most important component is its engine—the soul of a car. In fact, you may have a maintained and sparkling set of wheels in your car, but

if its engine is not working, it is as good as waste. In order to make sure that your car has a long life, you should maintain your vehicle regularly. Engine is a power producing unit in automobile system, where fuel is burnt to create heat energy and that heat energy is converted into kinetic energy. It is a complex unit with different parts, which work together and produce power for the movement of a vehicle.

One must regularly check the engine for leakages as:

- the leakage of combustible gases can reduce the mileage and pick-up.
- the leakage of coolants can affect the engine's temperature and cause overheating, due to which the parts can deteriorate.
- the leakage of the lubricating oil can increase the friction and reduce the engine's power output. Such leakages must be repaired in time to avoid failure of the engine.

Selective Procedure to Check the Leakage in a Vehicle's Engine

- Keep the vehicle on a hard surface.
- Open the engine bonnet and support with lever.
- Follow the steps given for checking the leakages.

Air cooled system leakage

Green colour is mentioned below point, it symbolises that there are chances of coolant leakage.

- Inspect its connections and the coolant tank.
- Inspect the radiator hose clips for looseness and if leakage is noticed, tighten the clips.
- Check the hose pipeline for distortion and deterioration and replace.
- Inspect the radiator cap, neck and radiator core for coolant leakage.
- Inspect for torn thermostat housing gasket, which may cause leakage.
- Inspect water pump seals and gasket for leakage of coolant.

Fuel leakage

Fuel leakage can be caused due to evaporation of fuel or broken or loose fuel line convection. It causes spot

of fuel underneath the car along with a strong smell. It reduces the mileage of vehicle.

Following areas must be inspected for fuel leakage

- Fuel tank exit and tank cap or rubber washer
- Flexible fuel line for slackness
- Torn fuel filter gasket or loose fuel filter
- Fuel pump connections and connectors
- Loose connection at nozzle or carburetor areas

Leakage of combustion gases

The leakage of combustion gases may be traced when black soot is noticed around the following areas of an engine:

- Cylinder head and block
- Torn cylinder head gasket
- Spark plug or nozzle
- Engine induction and exhaust manifold
- Value guide or improper tappet clearance

Lubricating oil leakage

The leakage of lubricating oil can be traced by following a few simple steps.

- Set a newspaper under the engine.
- Now run the engine for 5 min (do not move the vehicle).
- The newspaper will have spots if there is leakage.
- Exactly perpendicular to the spot will be the area of leakage. Stop the leakage by changing the gasket oil seal, etc.

Practical Exercise

1. List the types of leakages found in an engine.

S.No.	Types of leakage

Check Your Progress

A. Fill in the blanks

1. For fuel leakage _____, _____ and _____ must be checked in the engine.
2. Check the hose pipe for _____ or deterioration.
3. Inspect the radiator cap, neck and radiator core for _____ leakage.
4. Inspect radiator hose clips for _____, if leakage is noticed, _____ the clips.

B. Multiple choice questions

1. What is the power producing unit in an Automobile System?
   (a) Engine
   (b) Chassis
   (c) Piston
   (d) Connecting rod
2. Which colour indicates that there are chances of coolant leakage?
   (a) Green
   (b) Blue
   (c) Yellow
   (d) None of the above
3. Engine is where fuel is burnt to create heat energy and that heat energy is converted into _____.
   (a) kinetic energy
   (b) dynamic Energy
   (c) static energy
   (d) thermal energy

C. Answer the following questions

1. Why must leakages be controlled?
2. What are the steps to be followed while checking the leakages in an engine?

Session 2: Washing of an Engine

The modern automobile is captured with latest technology. So, while providing services like engine washing, care must be taken to avoid damaging the components.

The latest engines are compact and fitted in a small area. It is necessary to clean the engine at regular intervals to take away oily layers, depositions of muck

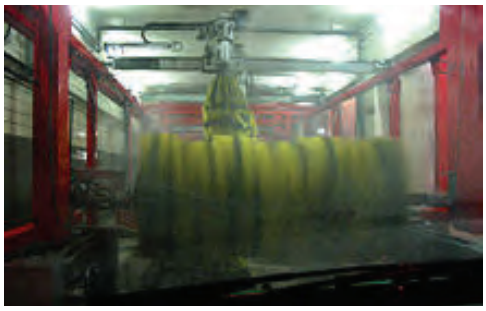

Fig. 5.2: Automatic car washing unit

(mud and water), which may cause the engine heat and deteriorate its performance.

Material and Equipment Required to Clean Engine

- Car washer
- Compressor
- Diesel sprayer gun, etc.

Steps to clean or wash the engine

- Keep the vehicle on a hard surface.
- Unlock the engine bonnet and support with lever.
- Inspect for external leakage of oil, coolant, gases, locate the area.
- Allow the engine to reach atmospheric temperature.
- Separate the negative terminal of battery for protection.
- Now use a diesel sprayer and spray only on oily layer of the engine.
- Now control the car washer and set the water spraying nozzle at a low force.
- Spray the water and remove the oily layers and muck water from an engine.
- Now, take some liquid soap and apply the soap gradually in the area where the hand can reach.
- Again, with low water pressure, clean the engine externally.
- Also clean the bonnet area and engine room.
- Now, start the compressor and give air pressure to remove the water from the electrical and electronic gadgets.
- Allow the engine to dry.
- Connect the battery terminal and start the engine and check for smooth working.

Precautions

- Do not use high pressure to clean engine.
- Safeguard sensors, spark plugs, nozzle and electronic gadgets from water.
- Do not give water pressure when engine is in running condition.

- Do not clean the engine when it is hot.
- Do not blow air at high pressure.

Practical Exercise

1. List the elements of safeguard during engine washing.

Sr. No.	Elements

Check Your Progress

A. Fill in the blanks

1. Latest engines are _____ and fitted in the small area.
2. _____ is used for washing the engine.
3. Spray _____ and remove the oily layers and muck water from an _____.
4. Liquid soap should be applied slowly in the _____ where the hand can reach.
5. Do not clean the _____ when it is hot.

B. Multiple choice questions

1. Which of these is required to clean the engine?
   (a) Car washer
   (b) Compressor
   (c) Diesel sprayer gun
   (d) All of the above
2. What are the steps to clean or wash the engine?
   (a) Keep the vehicle on hard surface
   (b) Unlock the engine bonnet and hold up it properly
   (c) Allow the engine to reach atmospheric temperature
   (d) All of the above
3. What type of precaution should be taken for washing of engine?
   (a) Do not use high pressure to clean engine
   (b) Safeguard sensors, spark plugs, nozzle, and electronic gadgets from water

(c) Do not give water pressure when engine is in running condition
(d) All of the above

C. Answer the following questions

1. Why is washing the engine necessary?
2. List the steps to be followed while washing the engine.

Session 3: Tuning Fuel System of an Engine

Engine tuning is the adjustment or modification of the internal combustion engine or Engine Control Unit (ECU) to yield optimal performance and increase the engine's power output, economy, or durability.

It is necessary to inspect and adjust the following systems of an engine:

- Fuel system
- Ignition system
- Cooling system
- Lubrication system
- Mechanical system

Steps for fuel tuning

- Clean air cleaner and fuel filter regularly
- Remove the tank cap
- Inspect the rubber washer
- Clean the vent hole to maintain atmospheric pressure on the fuel
- Now inspect the fuel line for leakage and if flexible fuel line is damaged, replace immediately
- Inspect the suction or vacuum of fuel pump.
- Check the fuel pump pressure
- Compare reading with specification as specified in the service manual

Setting idle speed of an engine

- Warm up the engine and turn the idle speed screw in clockwise direction for the engine RPM to increase.
- Slowly turn the idle speed screw in the anticlockwise direction till you get the prescribed RPM.
- Use tachometer to read RPM.

- Now, turn the air screw in clockwise direction so that the engine stops.
- Slowly open the screw and start the engine till we get recommended the RPM of an engine.

Nozzle pressure test

- Remove the injector or nozzle from the engine.
- Hold the container and lower the injector or nozzle.
- Join the fuel pipe to the nozzle and start the engine
- Observe the injector or nozzle spray, if proper, fix it back to the cylinder head.
- Repeat for all cylinders

(If pressure is noticed less than necessary, calibrate the FIP pump.)

Precautions

- Do not pull out the flexible pipe connection.
- Do not over tighten the fuel line connection.
- Do not twist the fuel line.
- Do not work on the fuel system with flame or park.
- Change the gaskets to avoid evaporation of fuel after regular intervals.

Practical Exercise

1. List the steps used in tuning of fuel system.

Sr. No.	Steps used

Check Your Progress

A. Fill in the blanks

1. _____ is the adjustment or modification of the internal combustion engine.
2. Warm up the _____ and turn the idle speed screw in _____ direction to increase the engine's RPM.
3. Use _____ to read RPM.
4. Injector or nozzle is used in a(an) _____.

B. Multiple choice questions

1. _____ is the adjustment or modification of the internal combustion engine.
   (a) Tuning
   (b) Fuel system
   (c) Ignition system
   (d) Cooling system
2. Which of these is a step for fuel tuning?
   (a) Clean air cleaner and fuel filter regularly
   (b) Remove the tank cap
   (c) Inspect the rubber washer
   (d) All of the above
3. Which of these is a step of nozzle pressure test?
   (a) Remove the injector or nozzle from an engine
   (b) Hold container and lower the injector or nozzle
   (c) Join the fuel pipe to the nozzle and start the engine
   (d) All of the above

C. Answer the following questions

1. Why is tuning necessary?
2. What are the steps to be followed while tuning the fuel system?
3. What are the advantages of tuning?

Session 4: Tuning of Ignition System of an Engine

The ignition system plays an important role in the process of combustion. The system converts current from 12 volt to 20,000 volt. To ignite the charge, the advance spark or retarded spark leads to imbalanced combustion, which in turn affects the engine's performance and changes the engine tune. The thin wires supply current between 12 volt and are called low tension leads. The thick wires supply current of 20–25,000 volt and are called high tension leads.

The ignition system is classified as — primary circuit with LT leads and secondary circuit with HT leads. The connection from battery to ignition switch to HT coil and to the distributor – CDI comes under primary circuit.

Basic Steps for Tuning of Ignition System

- Inspect loose contact of the battery terminal
- Inspect the socket connection for slackness
- Check the connection to ignition switch
- Check the primary circuit of LT lead while inspecting connection
- Inspect the connection with pick-up coil and CDI unit
- Disconnect the sparkplug connection
- Now remove the distributor cap and check the HT lead for loose connections
- Check slot machine contact point for erosion or burn
- Inspect working of spark advance mechanism
- Clean distributor cap and fix it properly
- Using appropriate spanner loosen the spark plug slowly from each cylinder
- Inspect the spark plug condition
  - Black soot: rich mixture – cold engine
  - Dead white soot: lean mixture – hot engine
  - Brownish colour: normal
- Check for eroded central electrode and make it straight to maintain air gap
- Check for deposition and clean the plug with sand blast machine or emery paper
- Using wire feeler gauge, set the spark plug gap as per the specification
- Clean the spark plug threads
- Apply oil and check spark plug sealing gasket washer, if needed replace it
- To install plug, first fix it with hand
- Thread it smoothly and tighten the same with specified torque
- Connect the lead wire with plug
- Start the engine and check the engine sound and ascertain if there is any change in engine sound

Practical Exercise

1. List the steps used in tuning of ignition system.

S.No.	Steps used

Check Your Progress

A. Fill in the blanks

1. The ignition system plays an important role in process of _____.
2. Ignition system is classified in two ways _____ circuit with LT leads and _____ circuit with HT leads.

B. Multiple choice questions

1. The ignition system converts current from _____.
   (a) 12 volt to 20,000 volt
   (b) 13 volt to 40,000 volt
   (c) 14 volt to 30000 volt
   (d) None of the above
2. Thin wires and their connections supply current between 12 volt and are called _____.
   (a) low tension leads
   (b) high tension leads
   (c) multi volts
   (d) None of the above
3. The thick wires supply current of 20–25,000 volt and are called _____.
   (a) High Tension Leads
   (b) Low Tension Leads
   (c) 12volt to 20,000 volt
   (d) All of the above

C. Answer the following questions

1. Why is tuning of ignition system of engine necessary?
2. What are the steps to be followed while tuning the ignition system of an engine?

Session 5: Tuning of Lubrication System of an Engine

Lubrication plays a key role in the life expectancy of an automotive engine. It reduces wear or friction, heat, and clean engine parts, gives cushioning effect and fills the gap.

The engine lubrication system works on a pressurised system, in which the oil sump stores and collects the circulated lubricating oil. The oil pump circulates the lubricating oil to the engine components at the recommended pressure and controls by salty valve. The role of oil filter and strainer is to filter the circulated lubricating oil and re-circulate the same.

The lack of lubrication may lead to a noisy engine and also change the tune of the engine due to increased in friction. Thus, it is necessary to check the lubricating oil at specified intervals. Also change the lubricating oil if the oil looses viscosity or after the recommended interval of distance in kilometres.

Tuning Procedure

Slowly remove the dip stick from the sump and wipe it with cotton waste.

Now check the level on the dip stick and if it is low, check the quality of oil. If it is heavy, the quality of oil viscosity is better, now add the oil for proper level. If the oil is black, it lacks viscosity. Then change the oil and oil filter.

Fig. 5.3: Checking of Engine Oil

Fig. 5.4: Filling of Oil

Changing the Oil

- Bring the vehicle on lubrication bay and place the container below the drain plug.
- Using specified spanners, loosen the drain plug and drain the oil in container.
- Switch on the engine for 3 seconds so that engine becomes warm. It will remove any oil present in pores of the engine and the oil will be drained out easily.
- Fix the plug with a new washer and tighten the same with specified torque.
- Refill the lubricating oil from filler plug with the recommended quantity and quality.

Fig. 5.5: Changing of Oil Filter

Changing of Oil Filter

- Slowly remove the oil filter.
- Use rubber gasket of appropriate size and place the gasket in the housing groove. Check the gasket for any deformity or tear.
- Now, fix the new oil filter tightly at the specified torque.

Measuring Oil Pressure

- Start and run the engine to achieve optimum temperature.
- Check the oil pressure on pressure gauge and compare with the service manual.

Practical Exercise

1. List the steps used in tuning of engine lubrication system.

S.No.	Steps used

2. Draw the line diagram of engine lubrication system.

Check Your Progress

A. Fill in the blanks

1. _____ is used for lubricating the engine of a vehicle.
2. The lack of _____ may lead to a noisy engine and also change the _____ of the engine due to increase in _____.
3. Change the _____ oil, if it looses viscosity or after recommended distance of _____.

B. Multiple choice questions

1. The engine lubrication system works on _____.
   (a) pressurised lubrication system
   (b) compressed air system
   (c) mixed hydraulic system
   (d) None of the above
2. The role of oil filters and oil strainer in engine lubrication system is to _____.
   (a) filter the circulated lubricating oil
   (b) filter the circulated fuel
   (c) filter the circulated air-fuel mixture
   (d) None of the above

3. If oil quality is good, it means _____.
   (a) viscosity is high
   (b) pressure is low
   (c) lack of viscosity
   (d) None of the above

C. Answer the following questions

1. Why is engine lubrication necessary?
2. What are the steps to be followed while checking the lubrication system?
3. Why do leakages occur in lubrication systems?

Session 6: Tuning of Cooling System of an Engine

You must have observed at home that whenever there is rise in ambient temperature, we switch on the fan or AC to reduce the temperature. It makes the environment comfortable to work. Similarly, the cooling system in a car protects the engine from overheating. An efficient cooling system keeps the engine protected and removes 30% of the engine's heat. Overheating of the engine can lead to poor performance, distortion of components and shorter life. Therefore, checking the functioning of the cooling system and the level of coolant, at specified intervals, is a must. During summers, it should be checked more frequently.

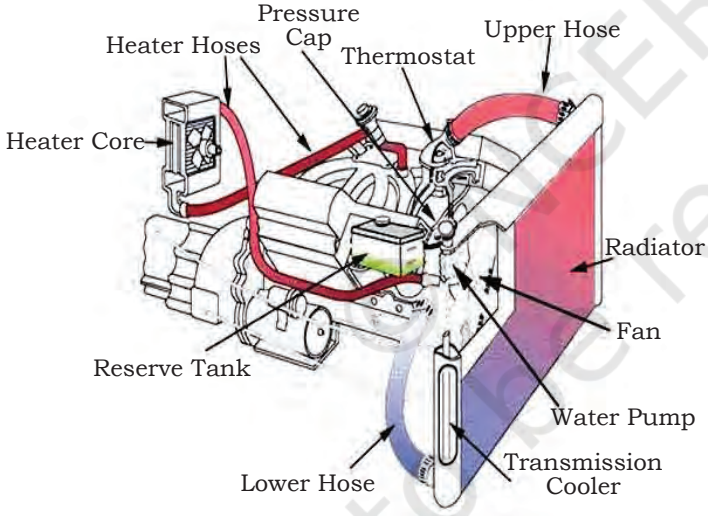

Fig. 5.6: Automobile Cooling System

Steps Involved in Checking the Cooling System

Reading of Temperature Gauge

Temperature gauge is fixed on the dashboard, which regularly monitors the variation in engine temperature. Moderate temperature of engine is 75–80 degree centigrade, which needs to be maintained.

Parts of Cooling System

The cooling system of an engine includes the engine's water jacket, water pump, radiator and radiator cap, cooling fan, thermostat, hoses, heater core and overflow tank.

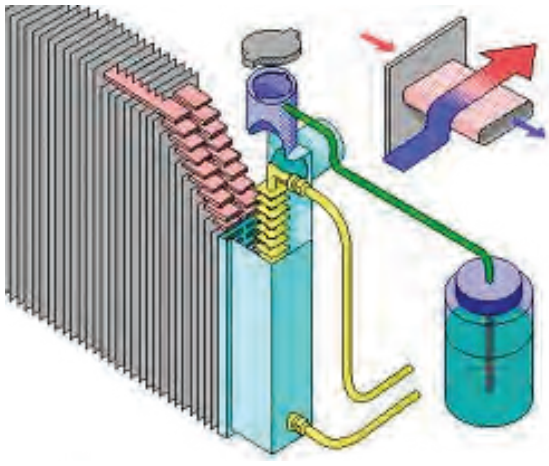

Fig. 5.7: Cooling Circulation

Checking circulation of water in cooling system

- Switch off the ignition switch of vehicle
- Remove the negative terminal from the battery
- Turn the upper radiator cap slowly and allow the steam or water vapour to release from the radiator
- Turn the radiator cap and remove the cap from the neck of the radiator
- Connect the battery terminal and switch on the ignition
- Start the engine at idle speed
- Inspect the circulation of water in the radiator
- Circulation of water should be observed as rate of inlet must be equal to rate of outlet of coolant
- It work healthy running of coolant system

Checking of coolant leakage

- Inspect coolant tank and its connections
- Inspect radiator hose clips for looseness and if leakage is noticed, tighten the clips
- Check hose pipe for distortion or deterioration and replace
- Inspect radiator cap, neck and radiator core for coolant leakage
- Inspect for torn thermostat housing gasket for leakage
- Inspect the water pumps seal and gasket for leakage of coolant

Setting of cooling fan belt tension

- Study belt for cracks and stress, cut deformation, wear and cleanliness. If necessary, change the belt.
- Check belt tension, it should be as 6–7 mm as deflection.

- To adjust the belt, tighten or loosen, change the position of the alternator.
- Tighten belt adjustment bolt and alternator pivot bolt.

Practical Exercise

1. List the steps used in tuning of cooling system.

S.No.	Steps used

2. Draw the line diagram of cooling system of a vehicle.

Check Your Progress

A. Fill in the blanks

1. _____ is used for cooling the vehicle.
2. Normal temperature of an engine is in the range of _____ and _____.
3. The percentage of heat removed by cooling system is ____ %.

B. Multiple choice questions

1. Cooling system in a car protects the engine from _____.
   (a) overheating
   (b) water heating
   (c) overflow
   (d) None of the above

2. Which of the following is not a part of the cooling system?
   (a) Water jacket
   (b) Water pump
   (c) Radiator and radiator cap
   (d) Axle
3. Cooling fan belt tension are _____.
   (a) 6–7 mm as deflection
   (b) 7–10 mm as deflection
   (c) 10–60 mm as deflection
   (d) All of the above

C. Answer the following question

1. Why is cooling of an engine necessary?
2. What are the steps to be followed while checking the functioning of the cooling system?

Session 7: Tightening of Fasteners (Nuts, Bolts and Screw)

As you know, the engine is a complex machinery in which different components are assembled using different types of fasteners. Power production, transmission of power, variation in speed and load, vibration leads to loosening of these fasteners. This may change the stability of the components and lead to bending of the vehicle's engine. Further, it may develop scratches, cracks, and may cause leakage of coolant, gases, etc., and affect the engine's performance.

Tightening of Cylinder Head, Induction Manifold and Exhaust Manifold

To avoid combustion gases, it is necessary to tighten the cylinder head in the following manner:

- Remove the tappet cover from cylinder head.
- Remove the rocker arm assembly.
- Slowly remove the pushrods (overhead valve mechanism).
- Use specific size of socket spanner with appropriate torque wrench.

Fig. 5.8: Cylinder Head

Fig. 5.9: Induction Manifold

- Strictly use the service manual as per the prescribed sequence.
- Tighten the cylinder with a specified torque.

Induction Manifold

Loose induction manifold may create vacuum leakage, which leads to supply of lean mixture that causes obstruction in engine running.

- Tighten the induction manifold using the specific size of socket spanner with appropriate torque wrench.
- Use the service manual strictly as per the prescribed sequence.
- Inspect the induction manifold gasket.

Fig. 5.10: Exhaust Manifold

Exhaust Manifold

Loose induction manifold may cause emission leakage and lead to blackening of bottom and may catch fire.

- Tighten the exhaust manifold by using a specific size of socket spanner with appropriate torque wrench.
- Use strictly the service manual as per prescribed sequence.
- Inspect the exhaust manifold gasket.

Material and Tools Requirement for Tightening of Fastener

- Socket spanner
- Tommey bar
- Extension bar or rod
- Torque wrench
- Torque wrench socket

Practical Activity

1. List the torque required for tightening of fasteners using service manual.

S.No.	Name of component	Tightening torque

Check Your Progress

A. Fill in the blanks

1. Tightening of cylinder head is required to avoid _____.
2. Loose induction manifold may cause emission _____.

B. Multiple choice questions

1. Loose induction manifold may create _____.
   (a) vacuum leakage
   (b) pressure leakage
   (c) hydraulic leakage
   (d) None of the above
2. Loose induction manifold may cause _____.
   (a) emission leakage
   (b) vacuum leakage
   (c) Both of the above
   (d) None of the above
3. The material and tools required for tightening of fastener include _____.
   (a) socket spanner
   (b) tommy bar
   (c) extension bar or rod
   (d) All of the above
4. Mallet is made of _____.
   (a) iron
   (b) wood
   (c) steel
   (d) aluminium

C. Answer the following questions

1. What are the different types of tools used in tightening of fasteners?
2. How is the torque wrench set?
3. List the steps used in tightening.

Session 8: Engine Timing (Tuning)

To run the engine smoothly, it is necessary to supply fuel by opening and closing the inlet 'valve'. Similarly it is also needed to remove the exhaust gases from the cylinder. Movements of the valves are related to the crankshaft revolution and engine (otto) cycle. It is necessary to check and set valve timing.

Fig. 5.11: Stroboscope Lamp or Gun

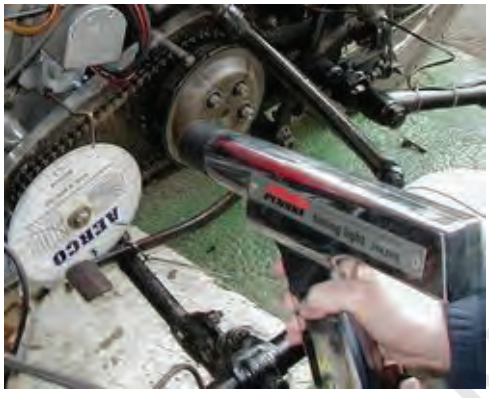

Fig. 5.12: Tuning

For the process of combustion, it is necessary to ignite the charge by using a sparkplug. The plug should ignite the charge at the end of compression stroke. There is a need to set the ignition system in relation to rotation of crankshaft.

Stroboscope Lamp or Gun

It is an instrument used to construct a cyclically moving object (our flywheel) that appears to be slow-moving or stationary. It is used in timing lights to dynamically set the explosion timing of an otto cycle combustion engine. The timing light is connected to the explosion circuit (mostly inductively) and used to illuminate the timing marks with the running engine. The perceptible position of the marks, frozen by the stroboscopic effect, indicates the current timing of the spark in relation to piston position.

These tools come in various shapes, mostly in gun or torch shape. A power supply (230V or 12V) is necessary to run them and they have a pickup unit (mostly an induction clamp to be put around the HT cable for impulse pickup).

In new vehicles, multipoint fuel injection system is used. In the process of combustion of fuel injection system, it is necessary to inject the fuel by using a fuel injector. The fuel injector injects the fuel at the right time at appropriate pressure at the end of compression stroke. There is a need to set the injection timing (FIP) system in relation to rotation of crankshaft. Thus, check and set fuel injection trimming.

Timing maintains the total functioning of the engine and govern the fuel economy.

Steps for Checking of Valve Timing

- Remove the timing cover
- Check the alignment of the following:
  - Turn the crankshaft pulley with the transmission belt. The mark on the pulley must align with the crankcase mark.

– At the same time the camshaft pulley mark must align with the crankcase marking. This indicates proper valve timing.

Steps for Checking of Ignition Timing

- Connect the stroboscope connection as per the prescribed manual.
- Now hold the stroboscope lamp and run the engine and flywheel at idle speed
- Check that the timing mark on the flywheel matches with the pointer of crankcase housing. The time lamp must glow, showing the alignment at the same time.
- This indicates proper ignition timing in the system.

Steps for Checking of Injector Timing

- Check the alignment and the FIP timing with camshaft gears or pulley, which ensures injection timing.

Practical Exercise

1. Visit the service centre and check the valve timing, ignition timing and injection timing of four types of vehicles.
2. Prepare a poster showing valve timing, ignition timing and injection timing of a vehicle.

Check Your Progress

A. Fill in the blanks

1. Valve timing is used for _____.
2. Ignition timing helps in _____ of an engine
3. Injection timing is used _____.
4. Stroboscope helps in _____ of ignition timing.

B. Multiple choice questions

1. Which component is used in timing lights to dynamically set the explosion timing of an otto cycle combustion engine?
   (a) Stroboscope Lamp or Gun
   (b) Piston
   (c) Ring
   (d) Rotary
2. The fuel injector injects the fuel at the right time at the end of _____.
   (a) suction stroke
   (b) compression Stroke
   (c) expansion Stroke
   (d) exhaust
3. Full foam of MPFI system _____ _____ _____ _____.
   (a) Multi Point Fuel Injection
   (b) Multi Fuel Point Injection
   (c) Multi Point Fuel Induction
   (d) None of the above
4. What is the full form of CVTI?
   (a) Charged Motion Variable Time Ignition
   (b) Changed Motion Variable Time Ignition
   (c) Combustion Motion Variable Time Ignition
   (d) All of the above

C. Answer the following questions

1. What is meaning of timing?
2. Give the differences between ignition and injection timing.
3. Name tool used in checking engine timing.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-1

A. Fill in the blanks

1. For fuel leakage _____, _____ and _____ must be checked in the engine.
2. Check the hose pipe for _____ or deterioration.
3. Inspect the radiator cap, neck and radiator core for _____ leakage.
4. Inspect radiator hose clips for _____, if leakage is noticed, _____ the clips.

B. Multiple choice questions

1. What is the power producing unit in an Automobile System?
   (a) Engine
   (b) Chassis
   (c) Piston
   (d) Connecting rod
2. Which colour indicates that there are chances of coolant leakage?
   (a) Green
   (b) Blue
   (c) Yellow
   (d) None of the above
3. Engine is where fuel is burnt to create heat energy and that heat energy is converted into _____.
   (a) kinetic energy
   (b) dynamic Energy
   (c) static energy
   (d) thermal energy

C. Answer the following questions

1. Why must leakages be controlled?
2. What are the steps to be followed while checking the leakages in an engine?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-2

A. Fill in the blanks

1. Latest engines are _____ and fitted in the small area.
2. _____ is used for washing the engine.
3. Spray _____ and remove the oily layers and muck water from an _____.
4. Liquid soap should be applied slowly in the _____ where the hand can reach.
5. Do not clean the _____ when it is hot.

B. Multiple choice questions

1. Which of these is required to clean the engine?
   (a) Car washer
   (b) Compressor
   (c) Diesel sprayer gun
   (d) All of the above
2. What are the steps to clean or wash the engine?
   (a) Keep the vehicle on hard surface
   (b) Unlock the engine bonnet and hold up it properly
   (c) Allow the engine to reach atmospheric temperature
   (d) All of the above
3. What type of precaution should be taken for washing of engine?
   (a) Do not use high pressure to clean engine
   (b) Safeguard sensors, spark plugs, nozzle, and electronic gadgets from water
   (c) Do not give water pressure when engine is in running condition
   (d) All of the above

C. Answer the following questions

1. Why is washing the engine necessary?
2. List the steps to be followed while washing the engine.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-3

A. Fill in the blanks

1. _____ is the adjustment or modification of the internal combustion engine.
2. Warm up the _____ and turn the idle speed screw in _____ direction to increase the engine's RPM.
3. Use _____ to read RPM.
4. Injector or nozzle is used in a(an) _____.

B. Multiple choice questions

1. _____ is the adjustment or modification of the internal combustion engine.
   (a) Tuning
   (b) Fuel system
   (c) Ignition system
   (d) Cooling system
2. Which of these is a step for fuel tuning?
   (a) Clean air cleaner and fuel filter regularly
   (b) Remove the tank cap
   (c) Inspect the rubber washer
   (d) All of the above
3. Which of these is a step of nozzle pressure test?
   (a) Remove the injector or nozzle from an engine
   (b) Hold container and lower the injector or nozzle
   (c) Join the fuel pipe to the nozzle and start the engine
   (d) All of the above

C. Answer the following questions

1. Why is tuning necessary?
2. What are the steps to be followed while tuning the fuel system?
3. What are the advantages of tuning?

A. Fill in the blanks

1. The ignition system plays an important role in process of _____.
2. Ignition system is classified in two ways _____ circuit with LT leads and _____ circuit with HT leads.

B. Multiple choice questions

1. The ignition system converts current from _____.
   (a) 12 volt to 20,000 volt
   (b) 13 volt to 40,000 volt
   (c) 14 volt to 30000 volt
   (d) None of the above
2. Thin wires and their connections supply current between 12 volt and are called _____.
   (a) low tension leads
   (b) high tension leads
   (c) multi volts
   (d) None of the above
3. The thick wires supply current of 20–25,000 volt and are called _____.
   (a) High Tension Leads
   (b) Low Tension Leads
   (c) 12volt to 20,000 volt
   (d) All of the above

C. Answer the following questions

1. Why is tuning of ignition system of engine necessary?
2. What are the steps to be followed while tuning the ignition system of an engine?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-5

A. Fill in the blanks

1. _____ is used for lubricating the engine of a vehicle.
2. The lack of _____ may lead to a noisy engine and also change the _____ of the engine due to increase in _____.
3. Change the _____ oil, if it looses viscosity or after recommended distance of _____.

B. Multiple choice questions

1. The engine lubrication system works on _____.
   (a) pressurised lubrication system
   (b) compressed air system
   (c) mixed hydraulic system
   (d) None of the above
2. The role of oil filters and oil strainer in engine lubrication system is to _____.
   (a) filter the circulated lubricating oil
   (b) filter the circulated fuel
   (c) filter the circulated air-fuel mixture
   (d) None of the above
3. If oil quality is good, it means _____.
   (a) viscosity is high
   (b) pressure is low
   (c) lack of viscosity
   (d) None of the above

C. Answer the following questions

1. Why is engine lubrication necessary?
2. What are the steps to be followed while checking the lubrication system?
3. Why do leakages occur in lubrication systems?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-6

A. Fill in the blanks

1. _____ is used for cooling the vehicle.
2. Normal temperature of an engine is in the range of _____ and _____.
3. The percentage of heat removed by cooling system is ____ %.

B. Multiple choice questions

1. Cooling system in a car protects the engine from _____.
   (a) overheating
   (b) water heating
   (c) overflow
   (d) None of the above
2. Which of the following is not a part of the cooling system?
   (a) Water jacket
   (b) Water pump
   (c) Radiator and radiator cap
   (d) Axle
3. Cooling fan belt tension are _____.
   (a) 6–7 mm as deflection
   (b) 7–10 mm as deflection
   (c) 10–60 mm as deflection
   (d) All of the above

C. Answer the following question

1. Why is cooling of an engine necessary?
2. What are the steps to be followed while checking the functioning of the cooling system?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-7

A. Fill in the blanks

1. Tightening of cylinder head is required to avoid _____.
2. Loose induction manifold may cause emission _____.

B. Multiple choice questions

1. Loose induction manifold may create _____.
   (a) vacuum leakage
   (b) pressure leakage
   (c) hydraulic leakage
   (d) None of the above
2. Loose induction manifold may cause _____.
   (a) emission leakage
   (b) vacuum leakage
   (c) Both of the above
   (d) None of the above
3. The material and tools required for tightening of fastener include _____.
   (a) socket spanner
   (b) tommy bar
   (c) extension bar or rod
   (d) All of the above
4. Mallet is made of _____.
   (a) iron
   (b) wood
   (c) steel
   (d) aluminium

C. Answer the following questions

1. What are the different types of tools used in tightening of fasteners?
2. How is the torque wrench set?
3. List the steps used in tightening.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-5 SESSION-8

A. Fill in the blanks

1. Valve timing is used for _____.
2. Ignition timing helps in _____ of an engine
3. Injection timing is used _____.
4. Stroboscope helps in _____ of ignition timing.

B. Multiple choice questions

1. Which component is used in timing lights to dynamically set the explosion timing of an otto cycle combustion engine?
   (a) Stroboscope Lamp or Gun
   (b) Piston
   (c) Ring
   (d) Rotary
2. The fuel injector injects the fuel at the right time at the end of _____.
   (a) suction stroke
   (b) compression Stroke
   (c) expansion Stroke
   (d) exhaust
3. Full foam of MPFI system _____ _____ _____ _____.
   (a) Multi Point Fuel Injection
   (b) Multi Fuel Point Injection
   (c) Multi Point Fuel Induction
   (d) None of the above
4. What is the full form of CVTI?
   (a) Charged Motion Variable Time Ignition
   (b) Changed Motion Variable Time Ignition
   (c) Combustion Motion Variable Time Ignition
   (d) All of the above

C. Answer the following questions

1. What is meaning of timing?
2. Give the differences between ignition and injection timing.
3. Name tool used in checking engine timing.

Unit 6

Regular Maintenance of Transmission System

As we already know a vehicle is operated with an engine. The mechanism that transmits the power developed by the engine to the driving wheel is known as the transmission system. It is also called power train. This system contains components, such as clutch, gearbox, propeller shaft, differential unit, etc.

The transmission system of a car should be checked regularly for fluid level, filter, etc., for smooth operation of a vehicle.

In this Unit, you will develop an understanding of the role of the transmission system and its maintenance.

171169CH06

Session 1: Transmission System

The entire mechanism that transmits power from the engine to the wheel is known as the transmission system. It is also called power train. This system contains the following components, which are given below with their functions.

Clutch

The clutch engages and disengages transmission from the driving member or shaft to the driven member, which assists the gradual engagement and disengagement

Fig. 6.1: Gearbox

in transmission of power. In the engaged position, a clutch must transmit the total engine torque to the gearbox.

Gearbox or Transmission

Gearbox is a part of the transmission system as the gears play an important role in transmitting the engine power to the wheels and overcoming resistance like gradient resistance, air resistance and load resistance. Gears is placed between the clutch and propeller shaft or differential.

Propeller Shaft

To transmit the power with variation of the angle and variation in length in relation with front and rear axle, the propeller shaft is used; this is connected between gear box and final drive.

Differential Unit

The differential is a device that allows each of the driving wheels to rotate at different speeds, when the car turns a corner. In vehicles without a differential, both driving wheels are forced to rotate at the same speed, usually on a common axle driven by a simple chain-drive mechanism.

Cleaning of motorcycle driving chain

To increase the life of sprockets and driving chain rollers, it is necessary to follow the given sequence for cleaning the driving chain

- Remove the chain cover from the motorcycle.
- Turn the wheel and using a nose plier, remove the chain lock.
- Take out the chain from both the sprockets.
- Using diesel, thoroughly clean the chain and sprockets.
- Now, wipe the chain and place it in SAE 90 grade lubricating oil.
- Now place the chain on the sprockets.
- Slowly turn and check for free rotation.

Fixing a loose chain

- Loosen the rear wheel axle nut and the crushed drive plate nut.
- Tighten the adjusting nut equally on both the sides, wheel will turn backwards and the chain will become tight.
- There must be slackness of 8–10 mm, because while riding the chain will be stressed.

Practical Exercise

1. Identify and locate the different units of transmission system and fill the table.

S. No.	Name of the component	Function

Check Your Progress

A. Fill in the blanks

1. _____ and _____ are the components of transmission system.
2. Propeller shaft helps _____ in an engine.
3. Function of differential unit is to _____.

B. Multiple choice questions

1. Which system transmits power from the engine to the wheel?
   (a) Transmission system
   (b) Fuel supply system
   (c) Power supply system
   (d) Ignition system
2. What assists the gradual engagement and disengagement in transmission of power?
   (a) Clutch
   (b) Gearbox
   (c) Crankshaft
   (d) None of the above

3. Gear box is placed between _____.
   (a) clutch and propeller shaft or differential
   (b) rear axle and engine
   (c) connecting rod and crank shaft
   (d) None of the above

C. Answer the following questions

1. What is the importance of a transmission system?
2. Give the difference between clutch and gear.

Session 2: Clutch Maintenance and Adjustment

Clutch Maintenance

Like the care for most automotive components, a key aspect of clutch maintenance is reducing the amount of heat that it is exposed to. It is important to avoid situations where the clutch is partially engaged — like 'riding' the clutch between gearshifts — to reduce the amount of heat generated by internal friction. Operate the clutch lever or pedal and see, clutches fully disengage transmission of power from an engine.

When the clutch is engaged, ensure that it transmits the power completely without any slippage. For this purpose, there should not be any pivot friction in control cable connection or in clutch linkage. At regular intervals, clean and lubricate the linkage points and joints. Also tighten the slacken nut and fasteners to specified torque and ensure friction free movement of the clutch mechanism.

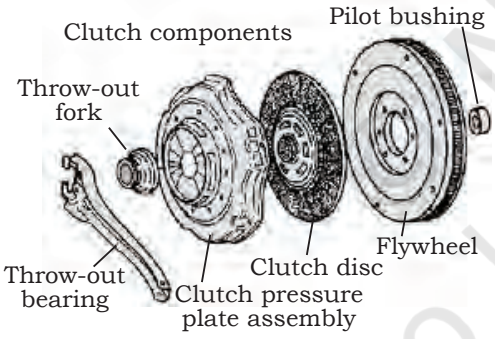

Fig. 6.2: Clutch

Clutch Adjustments

For the smooth functioning of the clutch, the following adjustments must be carried out.

Free Play Adjustments (Two-wheelers)

- First check the free play of clutch lever, which should be 10–12 mm. If the free play is incorrect, then adjust.
- Stretch the outer cable or sleeve by loosening the locknut. Then turn the tubular screw (adjustment

unit) anti-clockwise to reduce the free play and clockwise to increase the play.

- If the clutch play is not able to adjust by stretching of the outer cable then adjust the play by tightening the inner cable attachment with the clutch near gear box.

Free Play Adjustments (Four-wheelers)

The adjustment depends on the make of the four-wheeler. The clutch free play for four-wheelers is generally 15–20 mm at the clutch pedal. If the free play is less or more than the specified limit, it should be adjusted in the following way (for heavy vehicles)

- Loosen the lock nuts on both sides of turn buckle.
- Rotate the turn buckle according to the requirement to adjust the required play at the clutch pedal.
- After adjustment, tighten the lock nut.

Clutch Pedal Travel Adjustment

Follow the steps given below to check clutch pedal travel adjustments:

- Operate the clutch pedal and inspect it.
- The clutch pedal must move freely on the floor board.
- Carry out the necessary adjustments by adjusting the clutch linkages and adjustable sleeves.

Inspect Power Transmission from Clutch Assembly

Follow the steps given below to inspect power transmission from clutch assembly:

- Start the engine and run at idle speed.
- Now operate the clutch and check variation in noise
- Then engage the gears and slowly release the clutch.
- Notice for smooth transmission power without any jerky movement.
- Shift the next gear, check for the smooth sifting and hundred percentage transmission of power.

Practical Exercise

1. Identify and locate the different components of clutch.

Sr. No.	Name of the component	Function

Check Your Progress

A. Fill in the blanks

1. Clutch is used for _____ and _____ power.
2. The clutch free play for four-wheelers is generally _____.
3. Clutch unit is fixed between _____ and _____.

B. Multiple choice questions

1. A clutch must also transmit total engine _____.
   (a) torque
   (b) power
   (c) fuel
   (d) resistance
2. In a two-wheeler first check the free play of clutch lever, which should be _____.
   (a) 10–12 mm
   (b) 50–60 mm
   (c) 100–150 mm
   (d) None of the above
3. Stretch the outer cable or sleeve by turning the tubular screw (adjustment unit) anti-clockwise to _____.
   (a) reduce the free play
   (b) increase the free play
   (c) neutralise free play
   (d) None of the above
4. The clutch free play for four-wheelers is generally _____ at the clutch pedal
   (a) 15–20 mm
   (b) 20–30 mm
   (c) 40–50 mm
   (d) None of the above

C. Answer the following questions

1. What is the importance of clutch?
2. What are the effects of binding in clutch?

NOTES

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-6 SESSION-1

A. Fill in the blanks

1. _____ and _____ are the components of transmission system.
2. Propeller shaft helps _____ in an engine.
3. Function of differential unit is to _____.

B. Multiple choice questions

1. Which system transmits power from the engine to the wheel?
   (a) Transmission system
   (b) Fuel supply system
   (c) Power supply system
   (d) Ignition system
2. What assists the gradual engagement and disengagement in transmission of power?
   (a) Clutch
   (b) Gearbox
   (c) Crankshaft
   (d) None of the above
3. Gear box is placed between _____.
   (a) clutch and propeller shaft or differential
   (b) rear axle and engine
   (c) connecting rod and crank shaft
   (d) None of the above

C. Answer the following questions

1. What is the importance of a transmission system?
2. Give the difference between clutch and gear.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-6 SESSION-2

A. Fill in the blanks

1. Clutch is used for _____ and _____ power.
2. The clutch free play for four-wheelers is generally _____.
3. Clutch unit is fixed between _____ and _____.

B. Multiple choice questions

1. A clutch must also transmit total engine _____.
   (a) torque
   (b) power
   (c) fuel
   (d) resistance
2. In a two-wheeler first check the free play of clutch lever, which should be _____.
   (a) 10–12 mm
   (b) 50–60 mm
   (c) 100–150 mm
   (d) None of the above
3. Stretch the outer cable or sleeve by turning the tubular screw (adjustment unit) anti-clockwise to _____.
   (a) reduce the free play
   (b) increase the free play
   (c) neutralise free play
   (d) None of the above
4. The clutch free play for four-wheelers is generally _____ at the clutch pedal
   (a) 15–20 mm
   (b) 20–30 mm
   (c) 40–50 mm
   (d) None of the above

C. Answer the following questions

1. What is the importance of clutch?
2. What are the effects of binding in clutch?

Unit 7

Regular Maintenance of Gearbox

171169CH07

We will now learn about another important component of a vehicle, the gearbox. It helps in maintaining the speed of the vehicle. However, to ensure smooth gear change, the clutch needs to be properly adjusted.

In this Unit, you will understand the importance of gearbox maintenance.

Session 1: Lubrication of Gearbox

Fig. 7.1: Gear

To overcome resistances like gradient resistance, air resistance and load resistance, it is necessary to increase the tractive effort. We use gearbox in transmission by changing the gear ratios, which overcome the resistances. It is placed between the clutch and propeller shaft or differential. When gearbox increases efforts in transmission of power, heat is produced in meshing gears and contact surface area between meshing gear teeth comes under heavy friction.

The lubricating oil reduces friction and also provides a cushioning effect, when clutch shaft transmits the drive to the countershaft and power is transmitted to the main shaft gear. The selective mechanism locks the

respective gears as per the requirement (gear ratio) and power is then transmitted through the main shaft. In this transition, selective mechanisms, gear wheel, gear shaft splines, gear teeth develop friction and heat. To sustain the life of these components, it is necessary to lubricate these parts and change the lubricating oil at specified intervals. In motorcycles, the lubricating oil needs to be changed at 2,000–3,500 km, whereas in cars it needs to be changed at 10,000–15,000 km.

Steps for Changing Lubrication of Gearbox

Given below are the steps for changing lubrication of gearbox:

- Check for leakage of oil from the gearbox and clean the air breathers.
- Check the level of lubricating oil in the gearbox by loosening the oil level bolt, which is placed at the side of gearbox.
- When the gearbox is filled with the correct quantity of oil, it starts to flow through the level hole.
- To check the quality of oil in the gearbox, the following procedure may be adopted:
  - Take a drop of used oil and place it on the nail of thumb, while the thumb is being held vertically upward. Check the viscosity of old lubricating oil (flow of oil) in the downward direction. Similarly, check the flow of new oil, on the other hand's thumbnail, and compare the resistance to flow for both. The used oil will flow faster in comparison to new oil.
  - Check the oiliness of the oil by rubbing continuously on the hand skin. The old oil will smell of used oil. The oil should not have a burnt smell.

Changing the Lubricating Oil

Follow the steps given below to change the lubricating oil:

- Run the vehicle for 2–3 km.
- Place a container below the drain plug of the gearbox.

- Open the filler and drain plug and leave it for appropriate time, for the oil to completely drain out.
- Replace the washer of drain plug and tighten it to the specified torque.
- Refill the gear oil of specified grade and quantity up to the level mark.
- Close the level or filler plug.

Practical Exercise

1. Check the viscosity and oiliness of lubricating oil in an engine of a car.

Check Your Progress

A. Fill in the blanks

1. Lubricating oil is used for_____.
2. Lubrication removes _____ from engine.
3. Replace the _____at the manufacturer recommended interval.

B. Multiple choice questions

1. In motorcycles, lubricating oil should be changed after _____.
   (a) 2,000–3,500 km
   (b) 4000–5000 km
   (c) 7000–8000 km
   (d) None of the above
2. In cars, the lubricating oil should be changed after _____.
   (a) 10,000–15,000 km
   (b) 25000–27000 km
   (c) 3000–5000 km
   (d) None of the above
3. Steps for changing lubrication of gearbox include _____.
   (a) checking for leakage of oil from the gearbox
   (b) checking the level of lubricating oil in the gearbox by loosening the oil level
   (c) bolt when the gearbox is filled with correct quantity of oil
   (d) All of the above

4. Basic steps for changing the lubricating oil include ____ _____.
   (a) placing the container below the drain plug of gearbox
   (b) opening the filler and drain plug and leaving it for appropriate time
   (c) replacing the washer of drain plug and tightening it to the specified torque
   (d) All of the above

C. Answer the following questions

1. What is a gearbox?
2. Differentiate between oil and coolant.
3. Name the tools used for changing coolant in a vehicle.

Session 2: Setting of Gearbox

For easy shifting of gears, it is necessary to regularly lubricate the gear linkages or it may cause hard gear shifting and slipping of gear out of the mesh. To avoid this problem, it is necessary to inspect the alignment of the following parts:

- Gear lever with gear rod: excessive play is adjusted by adding thrust washers in gear lever casing. Also, the gear rod spring and lever boll should be checked for wear.
- Gear shifter fork should be aligned with shifting sleeve on the mainshaft of the respective gear. If the alignment is improper, loosen the fork bolt and adjust the same.
- Check the synchronising ring with the synchronising cone and with fixed hub mounted on main shaft. Inspect the internal and gear teeth for nick formation, polish it to solve the problem. In case of motorcycles, tighten the gear shifter lever, if it has slackened.

Go for road test after servicing and check the following:

- Gears shift easily from 1 to 5 and reverse, with appropriate speed and resistance.
- Power transmission should be smooth.

Fig. 7.3: Gear Shifter Fork

Practical Exercise

1. Identify and list the gear selective mechanism of a car.

Check Your Progress

A. Fill in the blanks

1. More play in gear linkage causes _____.
2. When gearbox increases _____ in transmission of power, heat is produced in meshing gears.
3. In a two-wheeler, the lubricating oil should be changed at every _____ km.
4. Check the level of lubricating oil in the _____ by loosening the oil level bolt.

B. Multiple choice questions

1. Which of these is not a component of the gearbox?
   (a) Gear linkage
   (b) Gear lever
   (c) Gear shifter lock
   (d) Piston
2. What should align with shifting sleeve on the main shaft?
   (a) Gear
   (b) Gear shifter fork
   (c) Gear linkage
   (d) Gear lever
3. For easy shifting of gears, it is necessary to regularly lubricate the _____.
   (a) thrust washer
   (b) gear linkages
   (c) spanner
   (d) bolt

C. Answer the following questions

1. What is the function of a gearbox?
2. What are the different combinations in gearbox?

A. Fill in the blanks

1. Lubricating oil is used for_____.
2. Lubrication removes _____ from engine.
3. Replace the _____at the manufacturer recommended interval.

B. Multiple choice questions

1. In motorcycles, lubricating oil should be changed after _____.
   (a) 2,000–3,500 km
   (b) 4000–5000 km
   (c) 7000–8000 km
   (d) None of the above
2. In cars, the lubricating oil should be changed after _____.
   (a) 10,000–15,000 km
   (b) 25000–27000 km
   (c) 3000–5000 km
   (d) None of the above
3. Steps for changing lubrication of gearbox include _____.
   (a) checking for leakage of oil from the gearbox
   (b) checking the level of lubricating oil in the gearbox by loosening the oil level
   (c) bolt when the gearbox is filled with correct quantity of oil
   (d) All of the above
4. Basic steps for changing the lubricating oil include ____ _____.
   (a) placing the container below the drain plug of gearbox
   (b) opening the filler and drain plug and leaving it for appropriate time
   (c) replacing the washer of drain plug and tightening it to the specified torque
   (d) All of the above

C. Answer the following questions

1. What is a gearbox?
2. Differentiate between oil and coolant.
3. Name the tools used for changing coolant in a vehicle.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-7 SESSION-2

A. Fill in the blanks

1. More play in gear linkage causes _____.
2. When gearbox increases _____ in transmission of power, heat is produced in meshing gears.
3. In a two-wheeler, the lubricating oil should be changed at every _____ km.
4. Check the level of lubricating oil in the _____ by loosening the oil level bolt.

B. Multiple choice questions

1. Which of these is not a component of the gearbox?
   (a) Gear linkage
   (b) Gear lever
   (c) Gear shifter lock
   (d) Piston
2. What should align with shifting sleeve on the main shaft?
   (a) Gear
   (b) Gear shifter fork
   (c) Gear linkage
   (d) Gear lever
3. For easy shifting of gears, it is necessary to regularly lubricate the _____.
   (a) thrust washer
   (b) gear linkages
   (c) spanner
   (d) bolt

C. Answer the following questions

1. What is the function of a gearbox?
2. What are the different combinations in gearbox?

Unit 8

Servicing of Wheels

Car tyres have an important bearing on the performance and safety of the car. Ensuring that the tyres are in good condition is important. Old and worn out tyres can easily lead to skidding of the vehicle.

In this unit, you will develop an understanding of the wheel of a car, hub greasing and bearing play adjustments of a vehicle, the maintenance of tyres and tube used in a vehicle.

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Session 1: Importance of Wheels

Without an engine a car can be towed, but it is not possible to move the car without wheels.

Tyres give a cushioning effect, and they must cope up with the steering system. They should be light in weight and be easy to remove and mount.

Types of Wheels

Following types of wheels are used in automobile:

- Disc wheels
- Light alloy cast or forged wheels
- Alloy wheels

Fig. 8.1: Disc Wheel

Disc Wheels

These types of wheels consist of two parts, steel rim which is generally well-based to receive the tyre and pressed steel disc. Steel disc is welded to the rim. It is light in weight. It is used in heavy vehicle like trucks, buses, etc.

Light Alloy Cast or Forged Wheel

These types of wheels are used for the cars. Wheels are made of aluminium alloy, which is a better conductor of heat.

Fig. 8.2: Alloy Wheel

Practical Exercise

1. Conduct a market survey and fill the table given below.

S. No	Name of vehicle	Type of wheels

2. Draw the images of different types of wheels.

Check Your Progress

A. Fill in the blanks

1. Wheels are used in _____.
2. Wheels are fitted in front and _____ of an engine
3. Alloy wheels are used in _____.
4. Disc wheels are used in _____.

B. Answer the following questions

1. What are the differences between disc wheels and alloy wheels?
2. Why is it important to service tyres of a vehicle?

Session 2: Importance of Hub Greasing and Bearing Play Adjustment

For friction-free rotation of wheels, it is necessary to lubricate, the wheel hub and wheel bearing at specified intervals. Bearing grease is used to lubricate these items.

Fig. 8.3: Wheel Hub

Wheel Hub

Wheel hub is a single casted unit mounted on stub axle shaft or on the casing. It consists of two taper roller bearings in which spacer is placed between two bearings. It holds break drum and wheel. Major function of wheel hub is to rotate freely on stationary shaft or casing. It is fastened by the castle lock nut on the axle or casing. During adjustment of bearing end play, shims are added to reduce the axle play. Wheel studs are fastened with wheel hub.

Fig. 8.4: Wheel Stud

Stub Axle

The front main axle is connected to the stub axle. The stub axle holds the wheel hub.

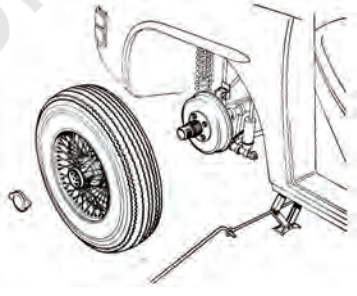

Fig. 8.5: Removing Wheel

Steps for Removing Wheel from Axle

- Place wooden blocks to lock the wheel.
- Loosen the wheel nuts by using wheel spanner.
- Lift the vehicle by placing a hydraulic jack under the front axle and make it rest on stands. Remove the jack.
- Remove the grease cup with the help of a hammer and screwdriver.
- Straighten the split pin and takeout by using combination plier.
- Unscrew the castle nut and take it out.
- Remove the brake drum from stub axle.
- Remove the wheel and hub from stub axle.

Steps for Cleaning the Wheel Bearings

- Remove the taper roller bearing from the hub and axle shaft.
- Take diesel oil in a tray and pour it in the bearing.
- Taking rubber pad, splash the grease from bearing.

- Thoroughly clean the bearing, hub and axle shaft
- Big and small taper roller bearings are checked for being worn out and assurance of no play and abnormal wear, etc.
- Wipe it out with dry clean cloth
- Now take the fresh bearing grease and fill it from broader side of taper roller bearing.
- Ensure grease reaches to the opposite side of the wheel.
- Now fix the bearing on the axle shaft with spacer.
- Fill the grease in the hub.
- Change the outer and inner grease seals.
- Fix the castle nut and tighten it to the specified torque.

Steps for Adjusting Wheel Play

- Place washer and tightened the castle nut.
- Check the wheel by turning
- If there is friction, loosened the castle nut
- Check again for friction
- Wheel should roll freely
- Lock the castle nut with the use of spilt pin
- Fit the grease cup by filling with new grease
- Lift the vehicle with jack and take out the stand
- Remove the jack by lowering it down

Steps to Remove the Broken Studs from the Hub

- Due to over tightening, overloading of vehicle may cause wheel nut or stud to break
- Use stud extractor or by using hand drill machine remove the broken stud without damaging the internal threads of hub
- Use tap to redress internal threads of the hub
- Choose new stud of proper size and fix in the hub

Precautions

- Over filling the grease in centre of the hub is not advisable, as it will flow out due to heat and may go in brake drum.
- Oil seal should be replaced, if needed.

- To allow the free movement of wheel and no play, the castle nut should be first tightened and loosened by a quarter or half thread.
- Castle nut must be locked by placing proper sized split pin.
- Grease cup should not be overfilled.

Practical Exercise

1. Visit an Automobile Service Centre and identify and list the bearings of different vehicle.

S. No	Type of vehicle	Bearing places

Check Your Progress

A. Fill in the blanks

1. Stud is used to hold_____.
2. To remove the stud _____ is used.
3. _____ is used in the bearing.
4. Replace the _____when it is broken.

B. Answer the following questions

1. What is hub greasing?
2. Differentiate between wheel hub and wheel axle?

Session 3: Tyre and Tube Maintenance

Tyre

As you know, a wheel is an important component of a vehicle. The wheel is an assembly of hub, disc or spokes, rim, tyre and tube. The wheels not only support the weight of the vehicle, but also protect it from road shocks.

Fig. 8.6: Tyre

Types of Tyres

The tyres may be of the following types:

1. **Tube tyre**: encloses a tube in which air is forced to a high pressure as a cushioning medium. The outer position of the tyre, which rolls on the road is made of synthetic rubber and is called tread. Beads are formed by reinforcing with steel wires in the inner edges. The beads act as strong shoulders, for bearing against the wheel rim. Rayon cords are formed into a number of piles. Where the beads and cords give strength to the tyre, the threads provide resistance against slipping and thicker surface at the outer periphery.
2. **Tubeless Tyre**: does not enclose a tube. The air under pressure is filled in the tyre itself. The inner construction of this tyre is almost the same as that of the tube tyre. A non-return valve is fitted to the rim through which the air is forced inside the tyre.

Advantages of Tubeless Tyre

- The tubeless tyres are lighter and run cooler than tubed tyre.
- The main advantage is that it retains air for a long period even after being punctured by nail, provided the nail remains in the tyre. But the tube tyre releases the air almost immediately after being punctured.

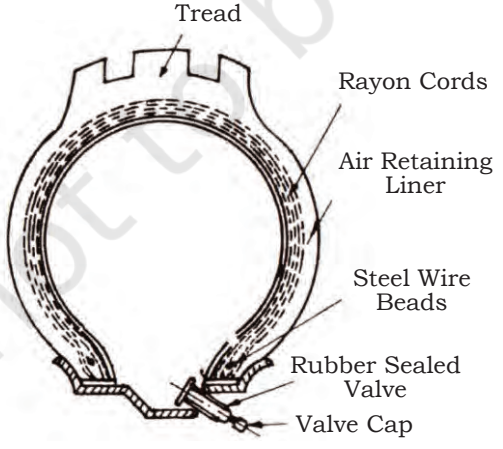

Fig. 8.7: Traditional Tube Tyre

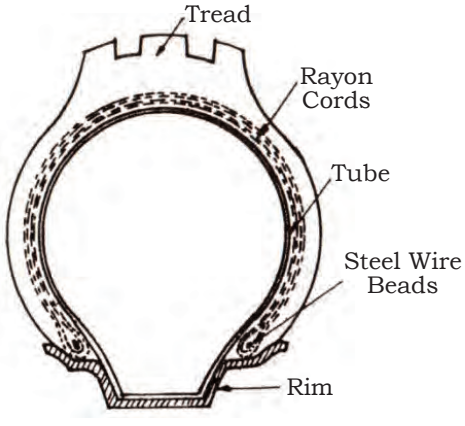

Fig. 8.8: Tubeless Tyre

- Any hole in the tubeless tyre can be repaired simply by rubber plugging.
- Ordinary punctures can be repaired with removing the tyre from the wheel.
- It can be retreated in the same manner as the tube tyre.

The tubeless and tube tyres are called pneumatic tyres, in which the air is forced inside the tube itself or in a tube which is fitted in the tyre. In both the cases, air is a cushioning medium. But in solid tube, it is not so. Neither the air is forced inside the tyre nor the tube is enclosed inside it. The tyre is completely solid and is mounted on the wheel rim. It is fitted on the wheels rim; it runs for a longer time.

Maintenance of Tyres and Tubes

- Maintenance of tyres and tubes is an important part of the service of a vehicle.
- Maintenance gives a cushioning effect and stability to the wheel, Following steps are to be followed.
- Clean the tyre regularly with water.
- Check for uneven tyre wear.
- Check damaged uneven thread.
- Check air pressure of tyres at regular intervals.
- Remove small chips of stone trapped in tyre treads with help of nose plier.
- Pressure of tyre should be maintained at the specified pressure given by manufacturer.
- Air pressure should be measured by using pressure gauge. Hold the pressure gauge on tube valve and press it gently, indicator will show air pressure of tube. If it is low, fill the air with the help of air compressor, again check the pressure, and repeat it in all four wheels and the spare wheel.

Rotation of Tyres

For normal wear of tyre uniformly, it is recommend that all four wheels should be shifted crosswise after every 10000 km run of vehicle or as per specification.

Practical Exercise

1. Measure and note the air pressure of different vehicles.

S.No.	Name of Vehicle	Front tyre pressure	Rear tyre pressure

Check Your Progress

A. Fill in the blanks

1. For normal wear of tyre uniformly, it is recommend that all wheels should be shifted _____ after every 10000 kms run of vehicle.
2. The tyre is _____on the wheel rim.
3. Nose pliers is used to _____ small objects
4. _____ is used for loosening parts.

B. Answer the following questions

1. Explain the importance of air pressure in tyres.
2. What are the advantages of rotation of wheels?
3. Differentiate between tyres and tubes.
4. Give the advantages of tubeless tyres.

SESSION 4: REPAIRING OF PUNCTURED TUBE

Whenever air in the tube is released, it causes a flat tyre and the vehicle is unable to move.

This may occur due to following reasons:

- Damage to the tube by means of sharp obstacles, such as alpine, nail, stone, etc.
- Due to faulty tube valve
- Rusted wheel rim
- Driving at low air pressure leads damage to the tube

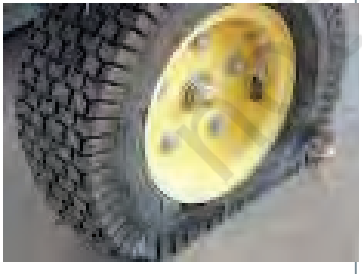

Fig. 8.9: Punctured Tube

Repairing of Punctured Tube

- Steps to remove the puncture from a tyre wheel;
- Loosen the wheel nuts
- Raise the portion of punctured wheel by placing the jack at lift point
- Remove the punctured wheel from hub
- Keep the removed nuts safely with washer
- By using tube valve, release the remaining air from the tube
- Place the blunt lever to remove the tyre bed from the wheel or place the wheel on the tyre removing machine
- Take out the tube gently by supporting the tube valve
- Inspect the inner portion of tyre and check for pointed items, remove with the help of nose plier
- Fit the valve back in the tube and fill the air. Check for leakage by placing the tube in water container.
- Mark the punctured area from where air is coming out
- Place a toothpick or matchbox stick in puncture hole

We can repair punctured tube with two processes given below.

Cold Patch Method

- Dry off the puncture tube
- Rub the punctured place with fine grade emery paper or rasp or rubber file
- Apply the cold patch adhesive solvent on and around the puncture area and allow it to dry for few minutes
- Take out the cover from the cold parch and place centrally on the punctured portion of the tube in mini press unit and press the cold patch
- After repairing the puncture, again fill the air and check for leakage
- Before fitting back tube in tyre, apply white powder (French chalk powder) inside the tyre

Fig. 8.10: Adhesive Solvent

Fig. 8.11: Photo of vulcaniser

- Fit tyre bed on wheel rim and see that this is fitted properly otherwise use the tyre removing machine
- Fix wheel back on the hub
- Diagonally tighten the nut with specified torque
- Fill the air of recommended pressure
- Remove the jack by lowering it

Hot Patch Method

- Hot patch method is carried out with the help of small, vulcanising machine
- After cleaning the punctured part with the help of emery paper or rasp file apply adhesive solvent (black in colour) on it
- Cut a piece of rubber in round sharp from the roll specially available for hot patch and place it centrally over the puncture, and press it
- Place the punctured portion downward on the heater plate and adjust the hand wheel of vulcaniser by rotating in clockwise direction so that the pressure plate just presses on the tube
- Switch on the vulcaniser and leave it for 10 to 15 min. Depending on the type of tube
- After a specified time is over, switch off the vulcaniser and remove the tube and cool the tube
- Fill the air and again check the tube for air leakage, if any
- After repairing the puncture, again fill the air and check for leakage
- Before fitting back tube in tyre, apply white powder (French chalk powder) inside the tyre
- Fit tyre bed on wheel rim and see that this is fitted properly other wise use tyre removing machine
- Fix wheel back on the hub
- Diagonally tight the nut with specified torque
- Fill the air of recommended pressure
- Remove the jack by lowering it

Fig. 8.12: Repairing Kit

Repairing a Tubeless Tyre

One of the advantages of tubeless tyre is that while repairing the puncture, the tyre need not be detached from the wheel rim.

Instruments and Material required

- Bodkin
- Wire brush
- Cold patch adhesive solvent
- Rubber plugs of different diameter
- Knife

Procedure

- Locate the puncture by inflating tyre and immersing the tyre with wheel rim in a water tank and mark it.
- Take out the nail if any and judge the puncture size, as the rubber plug to be selected is according to the puncture size.
- Clean the puncture and its surrounding with the help of a wire brush.
- Apply solvent with the help of bodkin to the punctured hole
- Select a correct size of rubber plug and attach it with the bodkin.
- Dip the bodkin along with rubber plug to the puncture with the help of bodkin
- Slowly take out the bodkin. The rubber plug will be in the puncture.
- Cut the rubber plug approximately 6 mm above the tyre trade.
- Fill the air in the tyre.
- Tyre is ready for use.

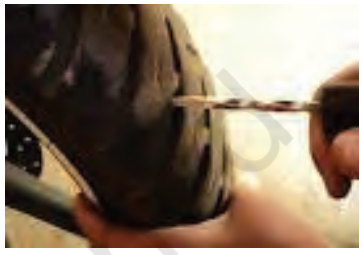

Fig. 8.13: Tubeless Tyre Repairing

Practical Exercise

1. Make a list of the steps used in cold puncture repairing

S. No.	Steps used

Check Your Progress

A. Fill in the blanks

1. _____is used for cleaning the tyre.
2. The puncture can be located by _____ and immersing the tyre with _____ in a water tank.
3. _____ is used in hot patch process.
4. For removing nail from tyre _____ is used.

B. Answer the following questions

1. Explain the process of puncture repairing.
2. Give the difference between hot and cold process of puncture repairing.
3. How is tubeless puncture repairing done?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-8 SESSION-1

A. Fill in the blanks

1. Wheels are used in _____.
2. Wheels are fitted in front and _____ of an engine
3. Alloy wheels are used in _____.
4. Disc wheels are used in _____.

B. Answer the following questions

1. What are the differences between disc wheels and alloy wheels?
2. Why is it important to service tyres of a vehicle?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-8 SESSION-2

A. Fill in the blanks

1. Stud is used to hold_____.
2. To remove the stud _____ is used.
3. _____ is used in the bearing.
4. Replace the _____when it is broken.

B. Answer the following questions

1. What is hub greasing?
2. Differentiate between wheel hub and wheel axle?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-8 SESSION-3

A. Fill in the blanks

1. For normal wear of tyre uniformly, it is recommend that all wheels should be shifted _____ after every 10000 kms run of vehicle.
2. The tyre is _____on the wheel rim.
3. Nose pliers is used to _____ small objects
4. _____ is used for loosening parts.

B. Answer the following questions

1. Explain the importance of air pressure in tyres.
2. What are the advantages of rotation of wheels?
3. Differentiate between tyres and tubes.
4. Give the advantages of tubeless tyres.

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-8 SESSION-4

A. Fill in the blanks

1. _____is used for cleaning the tyre.
2. The puncture can be located by _____ and immersing the tyre with _____ in a water tank.
3. _____ is used in hot patch process.
4. For removing nail from tyre _____ is used.

B. Answer the following questions

1. Explain the process of puncture repairing.
2. Give the difference between hot and cold process of puncture repairing.
3. How is tubeless puncture repairing done?

Maintenance of Brakes

A brake is a mechanical device, which inhibits motion. Its opposite component is clutch. Most commonly, brakes use friction to convert kinetic energy into heat, though other methods of energy conversion may be employed. Brakes are generally applied to rotating axles or wheels, but may also take other forms, such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute or airplanes with both wheel brakes and drag flaps raised into the air during landing.

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In this unit, you will develop an understanding of the brake maintenance at regular intervals so that vehicles efficiency increases.

Session 1: Brake and its Maintenance

Principle of Braking

The brake is a friction creating device, which causes speed reduction of the vehicle at a faster rate than the speed reduction obtained by changing the gears and closing down the accelerator.

Functions of a Good Braking System

- The brakes should stop the vehicle in shortest possible distance and without skidding the vehicle.
- The brakes should work equally well both on fair and bad roads.
- Pedal effort applied by the driver should not be more, so as, not to strain the driver.
- Brakes should work equally well in all weathers.
- It should have very few wearing parts.
- It should require little maintenance.
- Brakes, when applied should not disturb the steering geometry.
- There should be minimum sound when brakes are applied

Different Types of Brakes

- Mechanical brakes
- Hydraulic brakes
- Vacuum servo brakes
- Pneumatic brakes
- Disc brakes

Mechanical brakes

Brakes which operate mechanically by using cam, rod and linkage with drum brake.

Hydraulic brakes

Brakes which are operated by the pressure on hydraulic fluid are called hydraulic brakes. This braking system consists of master cylinder, fluid line, wheel cylinder and drum brake.

Vacuum servo brakes

Application of brake is assisted by engine vacuum for suction and is called vacuum servo brake. This system consists of vacuum reservoir, master cylinder, vehicle control unit and server with diaphragm.

Pneumatic brakes

Brakes which are assisted to work on compressed air are called pneumatic brakes. Braking system consists of following components; air compressor, air tank,

safety valve, brake valve, brake chamber, diaphragm or chamber with drum brake.

Disc brakes

Disc is mounted on the wheel, instead of brake drum, which rotates between caliper assembly. Caliper pads or friction pads are operated hydraulically by means of piston, which comes in contact with rotating disc. Due to friction it reduces the speed of the disc as well as wheel. System consists of master cylinder, caliper assembly, caliper pad or friction pad and disc.

Different types of braking systems are used in different class of vehicles as per the load carrying capacity, which takes care of the momentum of vehicle.

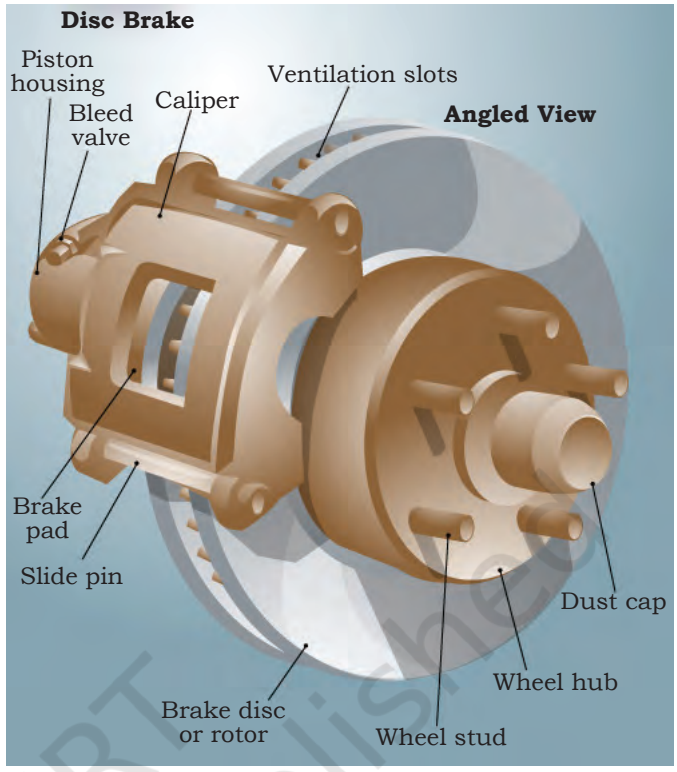

Fig. 9.1: Disc Brake

Servicing and Repairing of Mechanical Brakes

Steps for Repairing Mechanical Brakes

- Remove or unthread the wheel nuts with spanner and separate the wheel from brake drum.
- Straighten and pull out the spilt pin, fitted in castle nut, using combination plier.
- Lock the axle shaft and open the castle nut using socket and handle.
- Hammer the axle shaft lightly by using brass drift, this may contract the brake drum loose and remove the brake drum.
- Remove brake shoe lock, mount on anchor pin, with the help of nose plier.
- Serrate the brake shoes from brake lever cam and the steady post.
- Clean the brake shoes and the brake drum with the help of emery paper.
- Fit both the shoes on the cam and anchor pin and lock them.

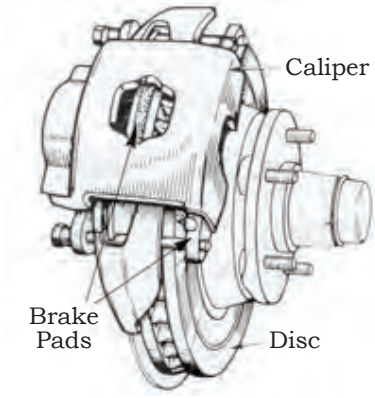

Fig. 9.2(a): Components of a Brake

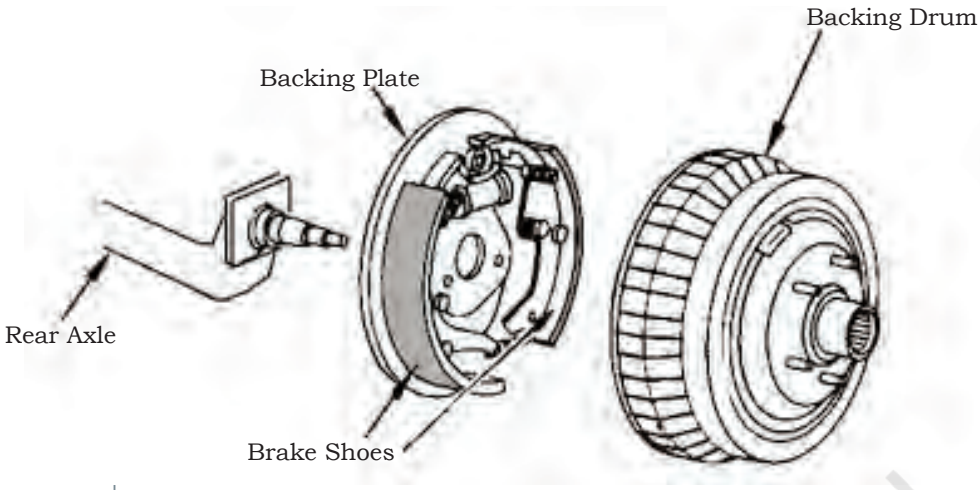

Fig. 9.2(b): Components of a Brake

- Fit the brake drum over the axle shaft and tighten the castle nut with the help of socket and handle.
- Tighten the brake shoe adjusting nut with the help of spanner, this makes the shoes to expand and grip the drum firmly.
- Loosen the adjusting nut by a little amount and turn the wheel, it must roll free. Do the shoe adjustment this way.
- Tighten the main nut locked it properly.
- Fit the wheel over brake drum and tighten wheel nuts.
- Take a road test of the vehicle.

Precautions during Servicing of Mechanical Brakes

- Shoe's lock must be placed properly.
- Shoe's adjustment should be done properly.
- If there is any lubricant, etc., on brake lining, it must be cleaned by washing the brake shoe with petrol and further cleaned using emery paper.
- Brake cable should be checked for its tension and fitted straight.
- Free play should always be kept in brake pedal.
- Shoe return spring should be checked for its tension and fitted straight.
- Replace the brake drum, if it is worn out beyond specifications; never get the sleeve fitted in it.

- Spilt pin should be placed in castle nut and bended.
- Spring washer should be placed below each wheel nut and these nuts must be tightened in the right manner and with the right torque. Over-tightening may damage the stud or threads.
- Brake's testing should be done at nominal speed of 20–35 km/hr only.

Hydraulic Brakes

Overhauling of Wheel Cylinder

- Place an obstacle to rear wheels and serrated from wheels hub plate using ring spanner.
- Rest the vehicle's front on iron horses by lifting with the help of jack and placing them below front axle.
- Straighten the lock washer of 'check nut' of stub axle.
- Serrate the brake drum from stub axle. The drum comes out with bearing.
- Serrate the brake hose pipe from the brake pipe line.
- Take out the shoe's lock with the help of combination plier and serrate the spring and locks from shoes.
- Take out the shoe return springs, this will make the shoes serrated from wheel cylinder and steady post.
- Take off the dust caps of wheel cylinder and dismantle them. There will be the piston, bore, spring and rubber seals. Check them for being 'OK'.
- Wash the assembly (metal parts) using petrol and fit the assembly (housing) on another plate and reassemble it.
- Fit the anchor plate over the stub axle and tighten it properly.
- Fit the shoes along with the return spring and lock lt.
- Join the brake hose connections and tighten the brake line.
- Place the wheel and brake drum over axle.

NOTES

- Adjust the wheel bearing's free play.
- Take out the iron horses by lifting the vehicle, a little up and then rest it down.
- Take out the jack, and tighten the hub nut.
- This completes your job of overhauling the wheel cylinder assembly.

Precautions during Servicing of Hydraulic Brake

- If return springs are worn out or weak, replace them immediately.
- Dust cover should be replaced if, it is torn- out.
- Brake lining should be cleaned with petrol and emery paper.
- Brake shoe lock should be placed properly.
- Anchor plate's bolt should be tightened properly.
- Bearing should be checked and adjustment should be made to it before fitting the brake drum.
- Wheel cylinder's rubber washers (kit) should be replaced.
- Brake hosepipe should be joined properly and if there is any leakage, it must be checked and rectified.
- Original and proper brake fluid should be filled.
- Brake system's bleeding should be done after completing the job.

Overhauling of Master Cylinder

- Drain out the master cylinder from the reservoir.
- Disconnect the brake pedal connection from the master cylinder.
- Using nose plier, remove the locking clip and then takeout piston, primary and secondary cups, check valve with spring.
- Wash all the components of master cylinder thoroughly with the help of clean brake fluid.
- Check the components for service limit.
- Clean the bypass and intake ports and outlet passage of master cylinder.
- Assemble all the components with new master cylinder kit.

- Fit back master cylinder on the vehicle.
- Connect the brake fluid line to the master cylinder outlet.
- Ensure that master cylinder reservoir cap is clean and clear.

Bleeding

- Process of removing trapped air from the fluid line is called ' bleeding' otherwise, it may cause spongy brakes.
- Fill the master cylinder's reservoir with brake fluid up to the topmost level marked on it.
- Ask the companion to sit on driver's seat and create fluid pressure by pressing and releasing the brake pedal several times. You will feel that the pedal becomes hard.
- Asked the companion to keep up foot pressure on brake pedal.
- Insert one end of the pipe over the bleeding nipple and let the other end in a glass bottle or jar.
- Release the fluid pressure by opening the bleeding nipple and farther most wheel cylinder from master cylinder. There will be bubbles with brake fluid coming out in the bottle or jar.
- Tighten the nipple and the brake pedal goes to floorboard as air and brake fluid are released from the nipple.
- Again ask your companion to repeat the procedure and release the pressure through the same nipple. This time there should be no bubbles and only the brake fluid should be coming out of it.
- Check the fluid level, it will be bit down, then top-up the level.
- Apply the same steps to other wheel cylinders also, turn by turn.
- Checked the free play of brake pedal.
- Adjust the free play by unthreading the push rod.
- Test the vehicle for roadworthiness. All the four wheels should have the same grip as this ensures a good brake.

NOTES

Important note

- Bleeding operation is to be carried out on the wheel cylinder, which is farthest from the master cylinder.
- If the master cylinder is provided with bleeder valve and bleeding to be carried out first on the master cylinder.
- Bleeding operation can also be carried out with the help of pressure bleeder machine.

Steps for Servicing of the Disc Brakes

- Keep the vehicle on hard surface.
- Loosen the wheel nuts.
- Raise the front portion of a car to support the chassis with stand.
- Remove the wheel nuts and remove the wheel.
- Loosen the castle nut and remove hub from splined shaft.
- Unscrew the bleeder valve and drain the brake fluid from fluid line.
- Now loosen the bolts of caliper holder from caliper assembly and remove the friction pads and dust caps.
- Slowly remove the scaling ring from assembly.
- Unload the caliper assembly.
- Remove the piston, dust cover, return spring and keep it aside.
- Thoroughly clean all components and inspect for wear.
- Inspect the disc surface for scratches.
- Measure the defect in the disc and if more, replace the disc or it will create shaking steering or brake judder.
- Inspect the thickness of disc (std-11mm, limit 9.5mm).
- Inspect the piston for wear or replace the kit.
- Assemble the disc on the hub.
- Fix the piston in caliper assembly with rubber seals.
- Also, replace the brake pads and assemble the wheel.

- Add the brake fluid in reserve tank.
- Carry out brake bleeding operation after adjusting friction pads.
- Test the working of brakes.

Parking Brakes

It is a special type of brake, designed to assist the normal braking system, when it is necessary to hold the vehicle or to hold heavy load descending or inclining. It is also used for parking a vehicle.

Level Servicing of the Parking Brake

- Pull up the parking brake lever.
- Count the number of notches the lever has travelled. If it is more than 3 to 4 notches, then, adjust brake shoe clearance or adjust the brake cable.
- Regularly check the free operation of the brake.

Practical Exercise

1. List the types of braking system used in a vehicle.

Sr.No.	Name of vehicle	Type of Brake

Check Your Progress

A. Fill in the blanks

1. _____ fluid is used for hydraulic brakes of the vehicle.
2. Brake fluid should be changed _____in a year.
3. _____ is a special type of brake, designed to assist the normal braking system.
4. Bleeding operation can also be carried out with the help of _____.
5. _____ is the reason for spongy brake.

B. Multiple choice questions

1. Mechanical brakes operate mechanically by using _____.
   (a) cam
   (b) follower
   (c) piston
   (d) None of the above
2. How can a vehicle be stopped in shortest possible distance and without skidding the vehicle?
   (a) With brake
   (b) By friction
   (c) By changing gears
   (d) With clutch
3. Which is not a type of brake?
   (a) Mechanical
   (b) Hydraulic
   (c) Vacuum servo
   (d) Rolling
4. Brakes which are assisted to work on compressed air are called _____.
   (a) pneumatic brakes
   (b) hydraulic brakes
   (c) vacuum servo brakes
   (d) disc brakes
5. Brakes which are operated by the pressure on hydraulic fluid are called _____.
   (a) hydraulic brakes
   (b) pneumatic brakes
   (c) vacuum Servo brakes
   (d) mechanical brake

C. Answer the following questions

1. Why are vehicle brakes necessary?
2. What are the steps to be followed while servicing mechanical brakes?
3. What are the steps to be followed while servicing parking brakes?

AUTOMOTIVE SERVICE TECHNICIAN CLASS 11 UNIT-9 SESSION-1

A. Fill in the blanks

1. _____ fluid is used for hydraulic brakes of the vehicle.
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4. Bleeding operation can also be carried out with the help of _____.
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B. Multiple choice questions

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Answer Key

Unit 1: Engineering Drawing

Session 1: Basic Geometric Constructions

A. Fill in the blanks

1. geometric constructions
2. three straight sides
3. unequal sides, unequal angles
4. four
5. four straight
6. three
7. seven
8. 10

B. State whether the following statements are true or false

1. True
2. False
3. True
4. False
5. True
6. True
7. False
8. True

C. Multiple choice questions

1. (a)
2. (a)
3. (a)
4. (a)
5. (a)

Session 2: Tools of Engineering Drawing

A. Fill in the blanks

1. smaller
2. appear
3. true
4. current
5. three axes, true

B. State whether the following statement are true or false

1. False
2. True
3. True
4. False
5. False
6. True
7. True
7. True
8. True
9. False

C. Multiple choice questions

1. (a)
2. (a)
3. (a)
4. (a)
5. (a)

Unit 2: Fasteners

Session 1: Automotive Bolts or Machine Screws

A. Fill in the blanks

1. device, affixes
2. stainless steel
3. fastener
4. studs, bolt
5. metric

B. Multiple choice questions

1. (a)
2. (a)
3. (a)
4. (d)
5. (a)

Session 2: Automotive Nuts

A. Fill in the blanks

1. threaded
2. bolt
3. pitch, screwed
4. internal
5. six

B. Multiple choice questions

1. (a)
2. (a)
3. (a)
4. (a)

Sessions 3: Automotive Studs

A. Fill in the blanks

1. fasteners, threaded
2. threaded
3. wheel
4. disc or drum hub
5. heavy duty, main studs

B. Multiple choice questions

1. (a) 2. (d) 3. (a) 4. (a) 5. (a)

Sessions 4: Automotive Washers and Rivets

A. Fill in the blanks

1. plate, distribute load, screw
2. dishes, hole
3. semi-permanent
4. heads
5. pinned connections
6. soft, fix
7. hole, chamfer, starting

B. Multiple choice questions

1. (a) 2. (a) 3. (a) 4. (a) 5. (a)

Session 5: Removal and Replacement of Damaged Fasteners

A. Fill in the blanks

1. jerk, corrosion
2. blade, groove
3. jerky, damaged
4. bolt
5. dust

B. Multiple choice questions

1. (c) 2. (d) 3. (d)

Unit 3: Material

Session 1: Engineering Material

A. Fill in the blanks

1. Ferrous metals, alloys
2. Steel
3. 0.03 % to about 1.2 %,
4. 0.15 %
5. cast iron

B. Multiple choice questions

1. (a) 2. (a) 3. (a) 4. (a) 5. (a)

Session 2: Basic Manufacturing Processes

A. Fill in the blanks

1. molten metal
2. manufacturing
3. Machining
4. rotary cutters
5. Grinding

B. Multiple choice questions

1. (a) 2. (a) 3. (a) 4. (a) 5. (a)

Unit 4: Measuring Equipment

Session 1: Handling and Usage of Direct and Indirect Measuring Instruments

A. Fill in the blanks

1. measurement
2. instrument, direct
3. simplest
4. measurement, internal
5. vernier
6. holes, distance
7. inspection, faces
8. final

B. Multiple choice questions

1. (a) 2. (a) 3. (a) 4. (a) 5. (a)

Session 2: Angular Measuring Instruments

A. Fill in the blanks

1. angular
2. intersecting
3. opposite
4. adjustable, transferring
5. precision, layout

B. Multiple choice questions

1. (a) 2. (a) 3. (a) 4. (a)

Session 3: Dial Indicator or Gauge and Other Gauges

A. Fill in the blanks

1. alignment, eccentricity
2. rack, pinion
3. plunger, micrometer
4. bore
5. diameter, ovality
6. pitch
7. mating

B. Multiple choice questions

1. (d) 2. (a) 3. (a)

Session 4: Instruments on the Dashboard of a Vehicle

A. Fill in the blanks

1. speed
2. revolutions per minute (rpm)
3. distance
4. amount
5. coolant
6. satellite navigation

B. Multiple choice questions

1. (d) 2. (a) 3. (b)

Unit 5: Regular Maintenance of an Engine

Session 1: Inspection of an Engine

A. Fill in the blanks

1. fuel tank exit, tank cap or rubber washer, loose fuel filter
2. distortion
3. coolant
4. looseness, tighten

B. Multiple choice questions

1. (a) 2. (a) 3. (a)

Session 2: Washing of an Engine

A. Fill in the blanks

1. compact
2. Diesel sprayer
3. water, engine
4. area
5. engine

B. Multiple choice questions

1. (d) 2. (d) 3. (d)

Session 3: Tuning Fuel System of an Engine

A. Fill in the blanks

1. Engine tuning
2. engine, clockwise
3. tachometer
4. engine

B. Multiple choice questions

1. (a) 2. (d) 3. (d)

Session 4: Tuning of Ignition System of an Engine

A. Fill in the blanks

1. combustion 2. primary, secondary

B. Multiple choice questions

1. (a) 2. (a) 3. (a)

Session 5: Tuning of Lubrication System of an Engine

A. Fill in the blanks

1. Pressurised lubrication system
2. lubrication, tune, friction
3. lubricating, interval of distance in kilometres

B. Multiple choice questions

1. (a) 2. (a) 3. (a)

Session 6: Tuning of Cooling System of an Engine

A. Fill in the blanks

1. Coolant 2. 75 and 80 Degree 3. 30 %

B. Multiple choice questions

1. (a) 2. (d) 3. (a)

Session 7: Tightening of Fasteners (Nuts, Bolts and Screw)

A. Fill in the blanks

1. combustion gases 2. leakage

B. Multiple choice questions

1. (a) 2. (a) 3. (d) 4. (c)

Session 8: Engine Timing (Tuning)

A. Fill in the blanks

1. fuel supply 2. opening and closing
3. injecting fuel 4. checking

B. Multiple choice questions

1. (a) 2. (b) 3. (a) 4. (a)

Unit 6: Regular Maintenance of Transmission System

Session 1: Transmission System

A. Fill in the blanks

1. Gearbox, clutch 2. transmit the power
3. rotate at different speeds

B. Multiple choice questions

1. (a) 2. (a) 3. (a)

Session 2: Clutch Maintenance and Adjustment

A. Fill in the blanks

1. engaging, disengaging 2. 15–20 mm
3. engine output shaft, gearbox input shaft

B. Multiple choice questions

1. (a) 2. (a) 3. (a)

Unit 7: Regular Maintenance of Gearbox

Session 1: Lubrication of Gearbox

A. Fill in the blanks

1. reducing friction
2. contaminants
3. lubricating oil

B. Multiple choice questions

1. (a)
2. (a)
3. (d)
4. (d)

Session 2: Setting of Gearbox

A. Fill in the blanks

1. wear and tear
2. tractive efforts
3. 2000-3,500
4. Gearbox

B. Multiple choice questions

1. (d)
2. (a)
3. (b)

Unit 8: Servicing of Wheels

Session 1: Importance of Wheels

A. Fill in the blanks

1. transport
2. rear
3. cars
4. heavy vehicles

Session 2: Importance of Hub Greasing and Bearing Play Adjustment

A. Fill in the blanks

1. wheel hub
2. hand drill machine
3. Grease
4. brake drum

Session 3: Tyre and Tube Maintenance

A. Fill in the blanks

1. crosswise
2. mounted
3. Types
4. remove
5. Wrench

Session 4: Repairing of Punctured Tube

A. Fill in the blanks

1. Brush
2. inflating tyre, wheel rim
3. Vulcaniser
4. nose plier

Unit 9: Maintenance of Brakes

Session 1: Brake and Its Maintenance

A. Fill in the Blank

1. Hydraulic
2. twice
3. Parking brake
4. pressure bleeder machine
5. Air

B. Multiple choice questions

1. (a)
2. (a)
3. (d)
4. (a)
5. (a)

Glossary

Casting: *is one of the oldest processes of manufacturing metallic components*

Casting: *is pouring of molten metal into a mould*

Circlip: *is a type of fastener having a semi-flexible metal ring with open ends.*

Clutch: *is a mechanical device, which engages and disengages power transmission especially from driving shaft to driven shaft.*

Dashboard: *is a control panel usually fitted in front of a vehicle's driver. In this panel, displaying instrumentation and controls panel for the vehicle's operation are displayed. It helps the driver to understand the various signals given by a vehicle like fuel capacity, temperature, engine speed, etc.*

Gearbox: *is used to change the speed and torque of vehicle according to variety of road and load conditions.*

Machining: *is the process of cutting, shaping, or removing of material from a work piece using a machine tool.*

Manufacturing: *is the process of turning raw materials into finished products.*

Overloading: *is capacity of a vehicle more than specified carrying capacity.*

Pneumatic: *containing or operated by air or gas under pressure.*

Rivet: *is semi-permanent mechanical fastener having a cylindrical shaft with head on one hand.*

Tubeless tyre: *are pneumatic tyres that do not require a separate inner tube.*

Turning: *is a type of machining or material removal process.*